# American eel distribution in tidal waters of the east coast of North America, as indicated by 26 trawl and beach seine surveys between Labrador and Florida

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APPENDIX

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## ABSTRACT

This study examines the distribution of American eels (*Anguilla rostrata*) in tidal waters of the east coast of North America, based on 23 bottom trawl and three beach seine surveys conducted between northern Labrador and central Florida. A total of 15,809 eels were captured in 248,769 trawl or seine sets. Eels were primarily captured in waters with some degree of protection from the open sea (classified as Tidal Fresh, Sheltered, or Semi-exposed), and with mean wind fetch, adjusted for the frequency distribution of wind directions, less than 60 km. Eels were rarely captured in unprotected marine waters. The percent of sets catching eels was lower in recent than in earlier years in surveys conducted in the Hudson estuary, Chesapeake Bay tributaries, and Pamlico Sound, but not in Delaware Bay. Catch rate of eels varied with depth within surveys, but the pattern of these relations varied among surveys. The percent of sets that caught eels diminished with distance from land in most surveys that had sufficient eel captures to evaluate trends. Untested but potentially important biases may affect the relation between eel abundance and trawl catch rates. In the Hudson Estuary and in the York and James tributaries of Chesapeake Bay, the percent of sets that captured eels was highest just upstream of the boundary between tidal saline and tidal fresh water, but in the Delaware River catch rates peaked just below this boundary. This study, the first to examine the distribution of growth-phase anguillid eels in tidal waters at a continental scale, was made possible by assembling a large number of datasets that covered a vast geographic area. However, many datasets for eastern North American marine waters have not yet been analysed for American eel distribution. This points to further opportunities for such datasets to contribute to ecological understanding and marine conservation.

## RESUMÉ

Cette étude examine la distribution de l'anguille d'Amérique (*Anguilla rostrata*) dans les eaux tidales de la côte est de l'Amérique du Nord, basée sur 23 relevés de chalut de fond et trois relevés de seine de plage, menés entre le nord du Labrador et Floride centrale. Un total de 15 809 anguilles ont été capturées dans 246,769 traits de chalut ou de seine. Les anguilles étaient surtout capturées dans les eaux avec un certain degré de protection de la mer ouverte (classées comme Tidales douce, Abritées, ou Semi-exposées), et avec fetch du vent moyen, ajusté pour la distribution de fréquence des directions du vent, inférieur à 60 km. Les anguilles étaient rarement capturées dans les eaux marines sans protection. Le pourcentage des traits ayant capturé les anguilles était inférieur dans les années récentes à comparer aux années antérieures dans l'estuaire du Hudson, dans la baie de Chesapeake, et dans le Pamlico Sound, mais pas dans la baie de Delaware. Les taux de prises variaient avec profondeur, mais le patron de ces relations variait entre les relevés. Le pourcentage des traits qui ont capturé des anguilles diminuait avec la distance de la berge dans la plupart des relevés dont le nombre de prises était suffisant pour évaluer les tendances. Dans l'estuaire du Hudson et dans les tributaires York et James de la baie de Chesapeake, le pourcentage de traits qui ont capturé les anguilles était au maximum juste en amont de la frontière entre les eaux tidales salines et les eaux tidales douces, mais dans la rivière Delaware le taux de prises était le plus élevé en aval de cette frontière. Cette étude, la première à examiner la distribution d'une anguille *Anguilla* en phase de croissance en eaux tidales à une échelle continentale, était rendue possible par l'assemblage d'un grand nombre de jeux de données qui couvrait une vaste aire géographique. Pourtant, un grand nombre de jeux de données pour les eaux marines de l'est de l'Amérique du nord ne sont pas encore analysés pour la distribution de l'anguille d'Amérique. Ceci signale d'autres opportunités pour de tels jeux de données à contribuer à la compréhension écologique et à la conservation en milieu marin.

## INTRODUCTION

The American eel (*Anguilla rostrata*) is the subject of intense conservation interest in both Canada and the United States (ASMFC 2012, COSEWIC 2012, DFO 2014, Jacoby and Gollock 2014), and has been called a "flagship species" for conservation (IUCN 2016). Due to the American eel's panmictic breeding system, facultatively catadromous life cycle, and vast continental range (Greenland to northern South America), a firm understanding of its population dynamics and status remains elusive (DFO 2010, Côté et al. 2013). The American eel is adapted to an exceptionally wide range of habitat types in fresh and saline waters during its growth phase (Helfman et al. 1987, Greene et al. 2009, Pratt et al. 2014). Within the saline (brackish or saltwater) zone, eels primarily occupy shallow and sheltered waters, but their distribution within such habitats is poorly known (ICES 2009).

As a step towards clarifying American eel distribution in saline waters, Cairns et al. (2012) classified eastern Canadian waters by degree of exposure to the sea, using a three-level scheme (Exposed, Semi-exposed, Sheltered). Most eel fishing sites were located in Sheltered habitat, with some in Semi-exposed and a few in Exposed habitat. On that basis Cairns et al. (2012) proposed Sheltered waters as the best current approximation of the saline habitat occupied by eels in eastern Canada. This proposition is based on the assumption that fishing locations are chosen solely on the basis of eel presence. However, location of eel fisheries could be influenced by other considerations, including risk of gear damage by storms in open waters.

Aquatic resources of the east coast of North America are commonly monitored through long-term marine survey programs. Most of these programs are operated by the Canadian and US federal governments, or by US state governments which have fisheries management authority within three nautical miles (5.56 km) of the coast. Most such monitoring programs use bottom trawls as sampling gear, but beach seines are also used (Chadwick et al. 2007, Collie et al. 2008, Belcher and Jennings 2009, Dunton et al. 2009, Frechet et al. 2009). Eels are susceptible to capture by both of these gears (Geer 2003, Weldon et al. 2005), although quantitative measurements of catchability are not available.

This study assembles data from 26 surveys conducted in tidal waters of the east coast of North America. The study is primarily oriented toward saline waters, but fresh waters are also treated where survey coverage extends into the fresh portion of tidal estuaries. Data are presented cartographically, by descriptive statistics, and by frequency distribution plots. Full statistical analysis will be published elsewhere.

The overall purpose of this work is to contribute to an improved understanding of eel use of tidal waters of eastern North America, and thereby increase capacity to conserve and sustainably manage the American eel stock.

## METHODS

### STUDY AREA AND TOOLS

The scope of this study is the tidal waters of the east coast of North America from the entrance to Hudson Strait to central Florida (Fig. 1). Cartographic analysis was performed with MapInfo 8.5 and ArcGIS 10.0 and 10.1. Maps were drawn using the NAD 83 datum.

Base maps for the east coast of Canada from the Strait of Belle Isle to the US border, and for the St. Lawrence estuary up to a point just east of Île d'Orléans, were assembled from 1:50,000 sheets of Natural Resources Canada's (NRCAN's) National Topographic Series (NTS) (http://geogratis.gc.ca/geogratis; see Cairns et al. 2012). Base maps for Labrador were assembled from 1:250,000 NTS sheets.

Coastlines used in base maps for US east coast states were derived from the Composite Shoreline map of the U.S. National Oceanic and Atmospheric Administration (NOAA) (http://shoreline.noaa.gov/data/datasheets/composite.html), which is based on manuscript sheets whose scales range from 1:5,000 to 1:20,000. Boundaries between states, and the boundary between the US and Canada, were derived from the US Census Bureau "States and Equivalent" map series (http://www.census.gov/cgi-bin/geo/shapefiles2013/layers.cgi).

In this paper, the coastline is considered to run along the outer boundary of tidal wetlands with emergent vegetation. The US National Wetlands Inventory (NWI) maps inland and coastal aquatic habitats according to a classification scheme described by Cowardin et al. (1979) and Dahl et al. (2009) (http://www.fws.gov/wetlands/Data/State-Downloads.html). State base maps used in this study were merged with NWI polygons representing habitats with emergent plants, to produce a coastline that runs along the seaward boundary of tidal emergent wetlands.

The coastline on base maps was drawn to the limit of salt penetration of estuaries. In Canada, this limit was based on marked narrowing of the river, the upstream extent of the intertidal zone depicted on topographical maps, literature reports, and local knowledge (Cairns et al. 2012). For US base maps, the salt penetration limit was derived from the boundary between Saline and Riverine habitat, based on NWI maps in which Riverine habitat is defined as waters having salinity less than 0.5 ppt. In six US estuaries, (Hudson, Delaware, Potomac, Rappahannock, York, James), tidal fresh waters were mapped as NWI's Riverine Tidal habitat category.

Base maps for Greenland, Baffin Island, Bermuda, the Bahamas, and Cuba, used in analysis of mean adjusted fetch (see below), are from www.diva-gis.org.

## WATERBODY AND RIVER CLASSIFICATION

Aquatic habitat in the study area was divided into Waterbodies, and certain waters were designated as Rivers, to facilitate analysis of eel habitat use.

There were 14 Waterbodies in total (Fig. 2). Canadian Waterbodies were the St. Lawrence Estuary, the Gulf of St. Lawrence, and the Canadian Atlantic waterbody which runs from the entrance to Hudson Strait to the Canada-US marine border. In the US, Waterbodies were designated within the Hudson Estuary, the Delaware Bay system, and the Chesapeake Bay system. All other US waters were designated as the US Atlantic Waterbody.

The Hudson Tidal Fresh Waterbody corresponds to the Riverine Tidal zone of the Hudson mainstem, as defined by the NWI. The Hudson Tidal Saline Waterbody runs from the downstream limit of the Hudson Tidal Fresh Waterbody to the lower estuary boundary. The lower estuary boundary was defined by a circle method similar to that used for exposure classification (Cairns et al. 2012, see below). In brief, using an interactive GIS software application, a circle of arbitrary size (10 km diameter) was moved from open water towards the estuary until it touched the coastline at two points. A line drawn between these points defined the lower estuary boundary.

The Delaware River Tidal Fresh Waterbody was defined as NWI's Riverine Tidal Fresh zone. The Delaware River Saline Waterbody runs from the lower limit of the Tidal Fresh Waterbody to the river mouth, defined as for the Hudson (see above). The Delaware Bay Proper Waterbody is between the downstream limit of the Delaware River Saline Waterbody and a line running from the Cape May lighthouse to the tip of Cape Henlopen.

Three Waterbodies were designated within Chesapeake Bay. The Chesapeake Tribs Tidal Fresh Waterbody consists of the Riverine Tidal Fresh zones of the Potomac, Rappahannock, York, and James estuaries, as defined by NWI. The lower limits of Chesapeake Tribs Saline Waterbodies are river mouths defined as for the Hudson (see above). For the Potomac, Rappahannock, York, and James estuaries, the upper limit of these waterbodies is the boundary with the Chesapeake Tribs Tidal Fresh Waterbody. Elsewhere, the upper limit is the coastline as defined by the base map. To qualify as part of the Chesapeake Tribs Saline Waterbody, an inlet had to contain 5.365 km$^2$, which is the area that lies between a circle 10 km in diameter and the corner of a square 10 km x 10 km. Islands that completely fit inside a circle of 1 km diameter were ignored in the mapping process. Islands in or near the central channel of Chesapeake Bay (Pooles Island, Bloodsworth Island, South Marsh Island, Smith Island, Tangier Island) were also ignored. Waters classified as Sheltered in the exposure classification system (see below) were included in the Chesapeake Tribs Saline Waterbody.

The Chesapeake Proper Waterbody consists of the open waters of Chesapeake Bay, between the lower boundary of the Chesapeake Tribs Saline Waterbody and the outer boundary of Chesapeake Bay. The outer boundary of Chesapeake Bay was a line running from the northern landfall of the Chesapeake Bay Bridge, to the north and south landfalls of the Chesapeake Bay Bridge on Fisherman Island, and on to the Cape Henry Lighthouse on the south side of the bay entrance.

The Albemarle Waterbody consists of Albemarle Sound, North Carolina, including Currituck Sound, whose northern arm (Back Bay) is in Virginia. The Pamlico Waterbody includes Pamlico Sound and Core Sound. The western boundary of Core Sound is drawn at 76.53°W. The boundary between the Albemarle and Pamlico Waterbodies follows that shown by the Albemarle-Pamlico National Estuary Program (http://www.epa.gov/owow_keep/estuaries/pivot/2008albemarle_pamlico.html).

The Hudson estuary, the Delaware estuary, and four estuaries on the west side of Chesapeake Bay (Potomac, Rappahannock, York, and James) were designated as Rivers (Fig. 3). Waters designated as Rivers consisted of tidal saline Waterbody habitat and tidal fresh Waterbody habitat for these estuaries.

## EXPOSURE CLASSIFICATION

Cairns et al. (2012) classified Atlantic Canadian waters south of the Strait of Belle Isle as Sheltered, Semi-exposed, and Exposed, based on the degree of exposure to the open sea. This study uses the same classification for Sheltered and Semi-exposed zones, but splits the Exposed zone of Cairns et al. (2012) into Exposed Bay and Exposed Ocean zones. It also adds the Deep Ocean classification for waters beyond the 500 m depth contour, and the Tidal Fresh classification for waters above the limit of salt penetration in estuaries where survey data were analyzed. This classification system was implemented for Atlantic waters between the Strait of Belle Isle and the tip of the Florida Keys. For waters between the entrance to Hudson Strait and the Strait of Belle Isle, only the Exposed Ocean category was mapped.

The classification process started by defining Sheltered zones. Using an interactive GIS software application, a 1.5 km diameter circle was moved toward an inlet until it touched the coast at two points. A line drawn between these points was taken as the outer boundary of the Sheltered zone. In the case of estuaries, the Sheltered zone included waters to the limit of salt penetration, as shown on the coastline base map. Semi-exposed and Exposed Bay zones were similarly defined with 15 km and 150 km diameter circles, respectively. Waters outside the Exposed Bay zone were classified as Exposed Ocean. The outer boundary of Exposed Ocean zones was defined by the 500 m depth contour. Waters outside this contour were classed as Deep Ocean.

To avoid assigning undue sheltering influence to small islands, islands that fit inside a 0.15 km diameter circle were ignored for the purpose of mapping Sheltered zones. Islands that fit inside 1.5 and 15 km diameter circles were ignored for mapping of Semi-exposed and Exposed Bay zones, respectively. To avoid assigning Sheltered, Semi-exposed, and Exposed Bay status to inlets with little concavity, minimum sizes were set as 0.12071, 12.071, and 1,207.1 km$^2$, respectively (Cairns et al. 2012).

If an enclosed water body is sufficiently large, substantial waves can be generated within it, even if its outlet to the sea is narrow. Hence any water body large enough to fully enclose a 15 km diameter circle was considered Semi-exposed, even if it would qualify as Sheltered based on the width of its outlet to the open sea. The only locations where this rule came into effect were Bras d'Or Lake in Nova Scotia and Albemarle and Pamlico Sounds in North Carolina.

In the estuaries of the Hudson, Delaware, Potomac, Rappahannock, York, and James rivers, surveys extended into fresh water as defined by NWI (see above). Waters in the fresh portions of these estuaries were classified as Tidal Fresh.

## RESEARCH SURVEYS

This study assembles data from aquatic faunal surveys in brackish and salt waters of the east coast of North America that were judged to be capable of capturing yellow (growth-stage) American eels. Because yellow eels that are not concealed in the substrate are strongly associated with the bottom of the water column (Chisnall 1995, Hallett 2013, Tomie et al. 2016), we looked for surveys whose gear samples the bottom portion of the water column (bottom trawls, beach seines). Surveys were conducted by government agencies or universities. ICES (2009) and Cairns et al. (2012) presented preliminary lists of such surveys. Further surveys were identified by searching literature databases and national and state websites and by soliciting input from government and academic marine scientists. In the US, states manage marine resources within three nautical miles (5.56 km) of their coasts. Accordingly, several states operate bottom trawl surveys to obtain data used to help guide inshore fisheries management. We placed particular emphasis on locating such surveys because their coverage was expected to overlap with habitat occupied by yellow eels. Once surveys were identified, we contacted data custodians and requested access to survey files.

We analysed 26 surveys in this paper. We identified, but lacked the time to analyse, an additional 41 surveys on the Atlantic coast and four on the US Gulf of Mexico coast which are likely capable of catching eels (Appendix A).

Analysed surveys covered waters of the east coast of North America between the northern tip of Labrador and the central east coast of Florida (Fig. 1). Table 1 presents abbreviations, sponsoring agencies, gear details, and pertinent references for the 26 surveys. Abbreviation suffixes indicate gear type (T=trawl, BS=beach seine). The datasets we analysed typically included the dates, times, locations, and water depths of sets, and the number of American eels caught. In one case (the Virginia Institute of Marine Science Trawl Survey, VIMS_T) the dataset made available to us recorded American eels by presence-absence only. Times of bottom trawl tows were usually included. Lengths and weights of captured American eels were provided in some datasets.

Most (23 of 26, 88%) analyzed surveys used bottom trawls (Table 1). Two mesh measurements were provided for most bottom trawls (main net body and codend). These measurements varied widely. Mesh in the main net bodies ranged from 6 to 160 mm and in the codends ranged from 3.2 to 51 mm (Table 1). Bottom trawl tow speed and duration for most offshore surveys varied, with most speeds between 4 and 7 km/h and most tow durations between 10 and 30 min. Tow duration was generally shorter in surveys that operated in small spatial areas such as inlets and bays (e.g. VIMS_T (5 min) and NCJUV_T (1 min)) (Table 1).

The remaining analysed surveys were conducted by beach seining in the southern Gulf of St. Lawrence (SGSL_BS), Long Island NY (LI_BS), and the Hudson Estuary (HE_BS).

## DATA ANALYSIS

### Data preparation and editing

We use the term "set" to indicate a single fishing event (e.g. shooting, towing, hauling back and emptying a trawl), and "site" to indicate the location of a set. A "station" is a site that was repeatedly sampled. Survey datasets were checked for missing, duplicated, or implausible data prior to analysis. Records lacking date, longitude, latitude, or information on eel numbers or presence/absence, were discarded. Reported sites were plotted and those that were implausibly distant from the main body of sampling sites were discarded. In the NCJUV_T survey, records giving locations on the ocean side of the Outer Banks barrier islands were discarded. Records were discarded if their reported locations were >200 m inland from the shoreline as defined by our base maps. In the Delaware River north of 39.620°N, sites listed in the PSEG_T dataset appeared to be consistently offset from the river as indicated on our base map. To correct this, locations of these sites were shifted 0.75 km north and 0.75 km west from the locations given in the original dataset. Sites with locations >500 m inland from the shoreline after this correction were discarded.

Sites were considered unique if no other site in the survey had the same coordinates, where coordinates were rounded to the nearest 0.0001°. A low mean number of sets per site was taken to mean that sites were chosen anew for each sampling period by a random selection process. A high mean number of sets per site indicates that sites were repeatedly visited (station-based design).

### *Fetch*

Fetch is the straight-line distance in a certain direction between a point and the coastline. Mean fetch is the mean of such distances when directions are set at regularly spaced compass intervals. Because the amplitude of wind-driven waves increases with the length of uninterrupted sea over which waves build, mean fetch can serve as a proxy for the degree of exposure to the open sea (Ekebom et al. 2003).

Wave amplitude does not increase infinitely with fetch. Instead, waves become fully developed at a certain fetch distance and do not increase in amplitude with greater fetch. Following Hill et al. (2010), we set maximum fetch at 650 km, which is the distance at which waves become fully developed under gale conditions. Hence, for the purpose of calculating mean fetch, any measured fetch that exceeded 650 km was truncated to 650 km.

Wind typically blows more often from some directions than other directions. Hence fetch calculations that are adjusted for the frequency distribution of wind directions will provide an improved indicator of exposure conditions. We established 21 Fetch Districts from Northern Labrador to Northern Florida (Fig. 4) and generated wind direction frequencies for these districts. For Canadian Fetch Districts, wind direction frequencies were obtained from Environment Canada's Canadian Wind Energy Atlas (www.windatlas.ca), which models wind directional frequency for any specified location. Frequencies were obtained for 25 to 90 coastal locations in each Fetch District (Fig. 4). The model gives wind frequencies at 30° intervals, in 12 compass directions. In this paper, mean fetches were calculated at 10° intervals, for 36 compass directions. Hence frequencies for 24 additional directions were calculated using weighted interpolation, where a 2/3 weighting factor was applied to the modeled output for the closest wind direction, and a 1/3 weighting was applied to the modeled output for the next-to-closest wind direction (Fig. 5).

Wind frequency distributions for US Fetch Districts were obtained from meteorological files recorded at airports on or near the coast and maintained by the US National Climatic Data Center (www.ncdc.noaa.gov/IPS/lcd/lcd.html) (Fig. 4). Wind direction was recorded in 36 compass directions, for a period of record from April 1998 to May 2014. Data were recorded hourly up to 2005, and thereafter at three hour intervals. Wind directions recorded as calm or variable were ignored, and frequencies were adjusted as necessary so that they summed to 1.

For some US Fetch Districts, the frequency distribution of wind directions showed irregular peaks and valleys, which could possibly be due to local topographic influences (Fig. 5). Wind direction frequencies for the US were therefore smoothed by applying weighting functions of 0.4, 0.2, and 0.1 for the direction itself, the direction's immediate neighbours, and the direction's next-to-immediate neighbours, respectively (Fig. 5).

Fetches were measured in 36 compass directions for each survey set (n=248,769). For sets within each Fetch District, fetches were calculated using a base map that included all shorelines within 650 km. Fetches were calculated by Tuuli, a program written in the Java language and based on an algorithm described by Murtojärvi et al. (2009) (Tuuli means wind in Finnish). Inputs were site locations and base map vertices converted to Cartesian coordinates. Tuuli rotated the coordinate system to make the fetch line parallel to the horizon, and then determined the distance between the site and the nearest shoreline that the fetch line intersected. Fetch can be calculated with the aid of programming tools within GIS packages. However, when fetch measurements are required for a large number of points and the base map is complex, computing time may become excessive. We ran Tuuli on a Dell laptop with an Intel i7 processor and Windows 7. All runs were completed within a few minutes. The longest run time (4 min 45 sec) was for the North Carolina Fetch District, in which fetch was calculated for 28,673 locations using a 183 megabyte base map that contained 5,763,041 vertices.

Mean fetch was calculated for each site. Adjusted fetch for a particular direction was calculated as (measured fetch in that direction) x (the proportion of time the wind blows from that direction)/(1/36). Adjusted mean fetch was the mean of these values.

### *River km*

For the Hudson, Delaware, Potomac, Rappahannock, York and James Rivers, the distance between sites and the river mouth was measured, and termed river km. River mouths were taken as the lower boundary of the River as defined by 10 km diameter circles (see above). For each river, a GIS polyline was drawn along the river axis. This line consisted of line segments that ran along the middle of each approximately straight reach. Polygons were drawn around approximately straight reaches which contained survey locations. For each polygon, a base point was established downstream of the polygon, and the distance from the base point to the river mouth was measured along the river axis. The distance between the base point and each survey location within the polygon was measured by Pythagoras' theorem, where one degree of latitude is 111.325 km and one degree of longitude (in km) is 111.325 x cos(latitude), where latitude is expressed in radians (http://www.ncgia.ucsb.edu/giscc/units/u014/u014.html). River km for each site was the sum of the distance between the river mouth and the base point, and the distance between the base point and the site.

### *Calculation of eels caught per swept area*

Bottom trawling and beach seining operate by dragging a net along the bottom. For bottom trawls, swept area is typically calculated as the product of the width of the net at its forward extremities (wingspread) and the distance the net is dragged (Doubleday and Rivard 1981, Walsh 1996). However, the area that is effectively fished by the gear involves complexities in the behaviour of both fish and the gear (Kotwicki et al. 2011). Some fish that are directly in the net's path may escape by passing over, under, or to the sides of the net. Fish may also be herded toward the net by the cables (bridles) that run between the net and the otter doors, which are set at a wider distance than the net wings (Clark 1993). The distance between net wings may vary with depth and towing speed (Walsh 1996).

This paper follows the convention that swept area is calculated from wingspread. For some trawl surveys, wingspread and/or swept area is available from reports by survey operators. Wingspread can also be estimated from headrope length using a mean ratio of wingspread to headrope length (Sparre and Venema 1998). For the 20 surveys which reported both wingspread and headrope length, the mean wingspread:headrope ratio was 0.590 (SD=0.096, Table 1). This value was used to estimate wingspread from headrope length, where wingspread was not available from reports by survey operators.

Survey areas were calculated as the areas of polygons drawn around survey sites (Fig. 1). These polygons were coarsely drawn and in some cases may have extended outside the boundaries within which survey planners designated survey sites.

### *Data presentation*

Survey data are reported cartographically, with descriptive statistics, and by plots of frequency distributions of the number of sets with and without reported eel captures across years, months, depths, distance from land, exposure category, mean adjusted fetch, and river km. Plots also report data numerically to facilitate quantitative analysis by future researchers. In surveys in which the greatest number of eels were captured, mean eels caught per set and the percentage of sets that caught eels (collectively termed catch rates) are also reported.

## RESULTS

Of the 248,769 sets analysed in this study (Figs. 6-30), most were conducted in the Canadian Atlantic (23.7%) and US Atlantic (33.7%) Waterbodies (Table 2). Surveys in the Gulf of St. Lawrence Waterbody (mostly NGSL_T, SGSL_T, SGSL_BS, NS_T) contributed 8.2% of all sets. HE_BS data from the Hudson Tidal Fresh and Saline Waterbodies contained 5.2% of all sets. Delaware River and Bay Waterbodies contained 5.8% of all sets, mostly from PSEG_T and DEDB_T. Sets in Chesapeake Bay (proper, fresh and saline tributaries), nearly all conducted by VIMS_T, comprised 14.3% of all sets.

Sets in the Hudson River, from HE_BS, comprised 29.9% of all River sets (Table 2). Sets in the Potomac, Rappahannock, York and James Rivers, from VIMS_T, comprised most (55.8%) of the remaining River sets.

A total of 15,809 eels were captured, but most captures were concentrated in a few surveys (Table 3, Figs. 6-30). The surveys with the highest (DEDB_T, 0.7923) and second highest (PSEG_T, 0.5120) mean eel catch per set were trawl surveys from the Delaware River and Bay system. The next three highest ranking surveys were beach seines (HE_BS, 0.3243; LI_BS, 0.1179; SGLS_BS, 0.0816). Eels captured per set cannot be calculated for VIMS_T because only eel presence/absence is available. The leading surveys by percent of sets with eels were DEDB_T (18.7120), HE_BS (17.0437), VIMS_T (12.8508), and SLE_T (5.3476). Four surveys (NL_T, NGSL_T NS_T, SEAMAP_T) reported no eel captures.

Yellow eels caught per ha of area swept varied from 0 (NL_T, NGSL_T, SLE_T, SGSL_T, NS_T, NEAMAP_T, SEAMAP_T) to 13.9 (HE_BS) (Table 4). The number of catchable yellow eels in the survey area, estimated as the product of yellow eels caught per area swept and survey area was greatest in the NCJUV_T survey (1,505,797 eels).

Survey datasets collectively covered the years 1959-2013, with the total number of sets per year following an increasing trend over this period (Fig. 31, All surveys panel). Other than SLE_T (two years) and LIA_T (three years), surveys have multi-year coverage with ongoing operation. Table 6 and Fig. 32 present the percent of sets that caught eels and the number of eels per set, by year, in surveys in which >150 sets contained eels. In 1978-1987, 81.7-100% of the sets in the VIMS_T survey were in three major west Chesapeake tributaries (Rappahannock, York, James), where eels are frequently caught (Fig. 26). Subsequently, a larger fraction of sets was conducted in Chesapeake Bay Proper where eels are less frequently caught. We did not plot eel catch rates for the VIMS_T dataset as a whole because this shift in geographic coverage is likely to bias results.

Seasonal coverage varied among surveys (Table 5, Fig. 33). Some surveys operated over the entire calendar year (albeit often with seasonally varying effort) (NL_T, NGSL_T, SGSL_T, SS_T, RI_T, NJA_T, VIMS_T, NCJUV_T, GA_T), some were suspended in winter (MENH_T, MA_T, NEAMAP_T, LIS_T, LI_BS, PB_T, NJDB_T, PSEG_T, SEAMAP_T), and some, along the northeastern coast of the US, did not operate during July and August (NEF_T, MENH_T, MA_T, and NEAMAP_T) (Fig. 33). In SGSL_BS, LI_BS, HE_BS, DEDB_T, and VIMS_T, the percentage of sets with eels was highest in late spring or summer, but NCJUV_T showed an additional seasonal peak in December-January (Fig. 34).

In general, surveys conducted in offshore waters operated around the clock with approximately uniform effort (sets per hour) over the 24-hr cycle, although SGSL_T operated in day only until 1985 (Table 5, Fig. 35). In 12 trawl surveys that operated in bays, estuaries, or ocean waters adjacent to shore, survey effort was concentrated in the day, although in some cases a small fraction of sets were made near the beginning of the end of the nighttime period. Time of sets was unavailable for five other trawl surveys in this category. Two beach seine surveys operated in the day; time data were unavailable for the third beach seine survey.

In offshore surveys that ran around the clock, eel captures occurred in all parts of the 24-hr cycle and showed no conspicuous circadian pattern (Fig. 35). For surveys that operated primarily in the day, capture frequency did not show any consistent pattern of variation across the sampling period (Figs. 35 and 36).

Mean number of sets per location fell into two groups (Table 7). In 18 surveys, this value ranged from 1 to 1.6, indicating that site placement was largely or exclusively random and that sites were not regularly revisited. In the remaining eight surveys, mean number of sets per site ranged from 27.7 to 2,637, indicating that sites were commonly revisited (station-based design). The most extreme example of a station-based design was RI_T, where all sets were conducted at only two sites.

Depths were recorded for all or nearly all sets in all trawl surveys except for LIS_T (Table 7, Figs. 37-39). Mean depth of sets for which data were available was 91.9 m (SD=158.4, range 0-1,605, N=195,576). The three beach seine surveys (SGSL_BS, HE_BS, LI_BS) were conducted in the intertidal or shallow subtidal zone and depths were not reported. SLE_T, NJDB_T, DEDB_T, NCJUV_T, and VIMS_T had sufficient data to show the relation between eel catch rate and depth, but the form of these relations varied among surveys (Fig. 40).

Mean distance of set locations to land was 53.0 km (SD=98.3, range 0 – 676) (Table 7, Figs. 41-42). The percent of sets that caught eels showed a diminishing trend with distance to land in DEDB_T, VIMS_T Chesapeake Rivers, and NCJUV_T (Fig. 43). However, in Chesapeake Proper, percent of sets which caught eels showed no trend with distance from land.

Mean eels per set was highest in the Tidal Fresh exposure category (0.279), followed by Semi-exposed (0.213), Sheltered (0.092), Exposed Bay (0.005), and Exposed Ocean (0.001) (Table 8, Figs. 44-45). No eels were captured in the Deep Ocean zone. Rank order of percent of sets with eels was similar except that the positions of Semi-exposed and Sheltered were reversed: Tidal Fresh, 23.5; Sheltered, 9.0; Semi-exposed, 8.7; Exposed Bay, 0.4; Exposed Ocean, 0.1.

For all sites, the mean fetch was 201.2 km (SD=216, range 0.0 – 650) and the mean adjusted fetch was 186.1 km (SD=207.2, range 0.0-650) (Table 7). Mean adjusted fetch was greatest in surveys that extended across the continental slope (e.g. NL_T, 492 km; SS_T, 436 km) and was least in beach seine surveys (LI_BS, 1.0 km; HE_BS, 1.7 km; SGSL_BS, 2.3 km) which were conducted in confined bays and estuaries (Table 7, Figs. 46-48).

In general, percent of sets that caught eels and mean eels per set fell to very low levels in sets where mean adjusted fetch exceeded 60 km (Table 3, Figs. 49-50). For LIA_T and NJA_T, these values peaked at mean adjusted fetches between 140 – 250 km. However, sites with low adjusted fetches are not available for comparison in these surveys, because they were conducted along shorelines that fronted on the open ocean. With data pooled in 2 km segments, eel catch rates generally showed irregular variation with mean adjusted fetch, although for VIMS_T percent of sets capturing eels declined smoothly after about 4 km mean adjusted fetch. In the plot for all surveys, sharp peaks in catch rates at 42 – 48 km mean adjusted fetch are primarily due to high catch rates in DEDB_T survey data (Fig. 51).

Fig. 52 plots the distribution of sets and sets that caught eels in the Hudson River, the Delaware River, and Rivers on the west side of Chesapeake Bay against river km. In rivers where survey coverage straddled the fresh-saline boundary, there was no consistent change in catch rate with salinity category (Fig. 53). Highest catch rates were found just above the fresh-saline boundary in the Hudson, York and James Rivers, but in the Delaware River catch rates peaked just below this boundary. Morrison and Secor (2004) estimated yellow eel densities in fresh and saline waters of the Hudson estuary by capture-mark-recapture (Fig. 53). Mean densities did not differ significantly between salinity zones (Cairns et al. 2009; analysis excludes the most upstream sampling site because bankside concrete revetments may have influenced local population density).

Tables 9 and 10 show eel weights, and lengths where weights were also reported. As a check on the plausibility of reported data, weights were calculated from lengths using length-weight equations from the closest available study (see compilation by Cairns et al. 2014). Calculated weight was 3.2% lower than reported length for the eel in SGLS_T, which indicates that the reported weight is plausible for the reported length (Table 9). For the NEAMAP_T and GA_T surveys, some calculated weights differed greatly (by up to 377%) from reported lengths. This implies that lengths and/or weights reported in these surveys are unreliable, or that the data refer to a species other than the American eel.

Mean lengths of two American eels measured in SLE_T were 79.4 cm (Table 10). The only other length measurement from a Canadian survey is 37.0 cm from the sole eel reported in SGSL_T. Mean lengths from US surveys (NEAMAP_T, PSEG_T, DEDB_T, NCJUV_T, NCAD_T, GA_T) ranged from 24.8 cm to 49.0 cm (Table 10). DEDB_T and NCJUV_T shared the smallest mean length for any trawl survey (24.8 cm), but NCJUV_T's lengths were much more broadly distributed than those of DEDB_T (Fig. 54).

The SGLS_BS dataset reported lengths in two categories, $\leq$9 cm and >9 cm. Of 524 eels categorized by length in this survey, 302 (57.6%) were $\leq$9 cm. Of the 302 small eels, 252 (83.4%) were caught in a single set, on 15 June 2012, in Miramichi Bay, New Brunswick.

## DISCUSSION

Recent studies based on otolith microchemistry have shown that eels are facultatively catadromous, with some eels residing in saline waters during their continental lives, some resident in saline waters, while still others shift between these habitats (Jessop et al. 2008). The recognition that American eels do not require fresh water to complete their life cycle has bolstered the view that saline habitat may be important to eel populations (ICES 2009).

This study is the first to examine the saline-water distribution of growth-phase anguillid eels at a continental scale. By assembling a large number of survey datasets over a vast geographic area, a broad picture can be drawn. In this study, degree of exposure to the open sea is indicated by a six-level categorical variable (Tidal Fresh, Sheltered, Semi-exposed, Exposed Bay, Exposed Ocean, Deep Ocean), and by the continuous variables of mean fetch and mean adjusted fetch. Analysis based on both variable types indicated that eels were most commonly captured in waters with at least some degree of protection from the open sea. Catch rates were highest in the Tidal Fresh, Semi-exposed, and Sheltered zones, and in waters with mean adjusted fetch of less than 60 km. However, within the waters classified in this way, there was no consistent trend towards greater catch rates with greater shelter. This suggests a possible threshold effect in the determination of eel habitat, i.e. that waters require a certain degree of exposure protection to be suitable as eel habitat, but additional protection beyond this level does not increase suitability.

Trawl surveys in large semi-enclosed embayments (notably Delaware Bay, Chesapeake Bay, and Pamlico Sound) and their associated estuaries accounted for the majority of captures. Most of the remaining eels were captured with beach seines in Sheltered waters, with mean adjusted fetches <2.3 km.

Mean adjusted fetch can explain a substantial proportion of the variation of biological communities along shorelines (Hill et al. 2010, Burrows 2012, Chollet and Mumby 2012). Models involving detailed oceanographic processes (e.g. wave diffraction, bathymetric friction) provide improved predictive power, but mean adjusted fetch has the advantage that it can be calculated solely from coastline maps and wind data (Callaghan et al. 2015). Fetch characterization over large geographic areas requires calculation of huge numbers of individual fetches, which may require excessive computational time, especially if computations are performed within a GIS environment (Yang et al. 2010, Murtojärvi 2016). In this study the problem of computation speed was resolved by the use of an efficient algorithm that rapidly calculates large numbers of distances between water points and complex shoreline maps on an ordinary PC (Murtojärvi et al. 2009, Murtojärvi 2016).

Although this study's objective is to understand the distribution of eels during their growth (yellow) phase, captures may also include migrating silver eels. During their silver phase, American eels cross coastal waters on their way to their spawning grounds in the Sargasso Sea. None of the databases made available to us distinguished eels by colour phase. In 2000-2001, SLE_T conducted three sets in June, 49 sets in July, 69 sets in August, and 66 sets in September in the St. Lawrence Estuary (Figs. 8 and 33). A set on 25 August captured one eel. The remaining nine eel captures occurred in September. The occurrence of eel captures in late August and in September, and their absence earlier in the year, is consistent with these eels being migrating silvers. Available lengths for captured eels (76.8 and 82.0 cm, Table 10) are likewise consistent with identification as migrating female silvers. The single eel reported from SGSL_T, was captured on 24 September 2006 in the central Gulf of St. Lawrence (Fig. 9). This eel was reported to measure 37 cm and weigh 86 g. Capture timing and size of this eel is consistent with its being a migrating silver male. Male eels are absent in natural populations in the St. Lawrence River basin, but occur in low proportions in waters associated with the Gulf of St. Lawrence (see review in Cairns et al. 2014).

NEAMAP_T reported all nine of its eel captures in fall (September and October) and no eel captures in spring (April and May), although survey effort was approximately evenly divided between the two seasons (Fig. 33). The concentration of eel captures in the fall is consistent with the presence of migrating silvers. In contrast, other surveys in open marine waters (NGSL_T, SS_T, NEF_T) showed eel captures in various months with no evident concentrations in fall.

Differences in gear and fishing methods across surveys may substantially affect eel catch rates. In particular, net size and distance towed varies among surveys (Table 1). These factors can be standardized by calculating eels (or yellow eels) caught per area swept (Table 4). If area swept is exactly known, and all eels within the swept area are caught, then eels per area swept equates to density. However, the metric of fish caught per area swept involves many biases and uncertainties, such that it cannot be interpreted as equivalent to density (Doubleday and Rivard 1981, Walsh 1996, Kotwicki et al. 2011). Area swept is not simple to define or measure, because fish near the edge of the net's path may be better able to escape the net than those near the middle of the net's path. The conventional meaning of "area swept" excludes the paths of the bridles that run from the net wings to the otter doors, but some fish in these zones may be herded into the net by the dragging bridles. The width swept by a net may also vary with tow speed, depth, and bottom type (Clark 1993).

A key issue in the American eel's susceptibility to trawl and beach seine capture is its diel behavioural cycle. Anguillid eels are considered to be nocturnal, but are nevertheless sometimes active in the day or inactive at night (Bohun and Winn 1966, Jellyman and Sykes 2003, Costa-Dias and Lobon-Cervia 2008). Nighttime visual observations from a glass bottom boat indicate that American eels commonly swim in the water column within a few cm of the bottom (Hallett 2013). Such eels would be vulnerable to capture by trawl or seine gear. The location of eels during daytime is not well documented. American eels wintering in eastern Canada spend both day and night concealed in the substrate, in mud burrows or rocky cavities (Tomie et al. 2013, 2016; Sweezey 2014). Eels wintering in muddy habitats make conspicuous pock marks at their burrow entrances (Tomie et al. 2013), but such marks have not been reported from the same habitat in summer. Summering eels might nevertheless spend their days in burrows that have no visible surface features. Eels occupying such burrows would have low vulnerability to daytime trawling and seining. Summering eels could also spend their days concealed in dense vegetation or bottom debris, where their susceptibility to trawl or seine capture would be greater than if they were in burrows, but less than if they were free-swimming.

If summering eels occupy substrate burrows during day, and are free-swimming at night, their susceptibility to trawl and seine gear should be higher at night than during day. In offshore surveys, which operated around the clock, eels were caught in both day and night with no obvious circadian pattern (Fig. 35). Most eel captures occurred in protected waters, but surveys in these waters were conducted during day only, or did not report sampling times. Nevertheless, it would be expected, if eels are generally nocturnally active, that catch rates would be higher during morning and evening twilight than during broad daylight. However, catch rate peaks were not observed in early morning and late evening (Figs. 35 and 36). Hence, in both open-water and protected-water surveys, timing of eel catches does not support the notion of a circadian effect in eel susceptibility to capture. However, we cannot provide a full test of such an effect due to the absence of nighttime catch rates in protected waters where most growth-phase eels live.

It is possible that eel susceptibility to trawl gear varies with depth. If eel diurnal activity increases with depth due to lower light levels at greater depths, eel susceptibility to daytime trawling would be expected to be lower in shallower water. Depth-dependent susceptibility to trawl gear could also arise from escape behaviours (Byrne et al. 1981). Tow vessels cause visual and auditory stimuli which may trigger escape behaviour. These stimuli will be more intense in shallow water, where the tow vessel is only a short distance above the animal, than in deep water.

In three locations, independent estimates of eel density are available for areas where yellow eel catches per swept area were calculated (Table 4). In southern Gulf of St. Lawrence bays and estuaries, estimated eel densities (75.6/ha) were much higher than yellow eels caught by beach seine per swept area (1.54/ha). Habitat, to which these values apply, broadly overlaps. The seine surveys were taken in intertidal and subtidal water to wading depth, while the density estimates were made in waters to ca. 3 m depth (Hallett 2013). In the Hudson estuary, eels caught by beach seine per swept area (13.9/ha) exceeded estimated eel densities (9.5/ha). Beach seine data were obtained along the shoreline, but the density estimates were made in waters 2 – 10 m deep along the edge of the channel (Morrison and Secor 2004). Eel length data were unavailable for HEB_BS, and it is possible that catches included many eels of elver size, which were excluded from yellow eel calculations in SGSL_BS. In Chesapeake Bay waters surveyed by VIMS_T, yellow eels caught per swept area were 0.63/ha, if one assumes that only one eel was caught per set. The actual number of eels caught per set is probably several times higher than this value. In any case the value would be lower than eel density calculated for the Potomac estuary (84.5/ha). Differences between eels caught per area swept and estimated densities may also be partly attributable to differences in size-selectivity of gear types.

Depth-capture rate relations plotted in this study (Figs. 37-40) suggest that eel abundance varies with depth, but that the form of this relation is inconsistent among sites. A review of American and European eel studies found similarly inconsistent patterns (Cairns et al. 2012). However, these plotted relations must be viewed with caution, given the possible variation of eel susceptibility to capture with depth (see above).

The rarity of American eel captures in open marine waters contrasts with the distribution of European eels (*Anguilla anguilla*) in the North and Baltic Seas. Data from beam trawl surveys conducted in the southern North Sea between 1970 and 2008 indicated eel presence in a coastal fringe up to 20 km wide (ICES 2009). Calculations based on swept area, and assuming 100% trawl efficiency, estimated a biomass of 222 t in 1982. This is probably an underestimate because trawl efficiency is unlikely to be 100%. Between 1964 and the 1980s, eels were commercially trawled in the German Bight of the southeast North Sea, in a zone roughly 20 – 50 km from the mainland coast (Aker and Koops 1974, ICES 2009). Fishing occurred primarily at depths of 10 – 50 m, and the population was estimated at 1.85 million eels with a biomass of 323 t. The population was dominated by yellow eels, but the proportion of silver eels peaked at 25% in November, apparently due to the passage of migrants on their way to the spawning ground.

Ubl and Dorow (2014) caught a mean of 8.6 European eels/ha in 100 x 100 m enclosure traps in open waters in the southwestern Baltic Sea. Mean catch rate was lower (2.3 eels/ha) in waters that were protected from the open sea by barrier islands. These catches per ha cannot be taken as density estimates, because the enclosure nets did not reach to the surface, and the gear was fished for only two days.

This study may be seen as part of a trend towards use of widely-sourced marine data assemblages (e.g. Ocean Biogeographic Information System, www.iobis.org; Census of Marine Life, www.coml.org). Several US reports have drawn on multiple survey data sets to investigate fish status and distribution over large geographic ranges (e.g. Rago et al. 1995, Reid et al. 1999, NMFS 2006, ASMFC 2013, US Fish and Wildlife Service 2013). This paper analyzed data from 26 surveys on the east coast of North America which were deemed capable of capturing eels. We identified, but did not treat, 41 other surveys in the study area (Appendix A). There are undoubtedly further relevant surveys which escaped our attention. This study focused on surveys in which a standard methodology is applied at multiple locations. Eel distribution and relative abundance may also be inferred from surveys which use site-specific methodologies (e.g. estuary trap programs, Cairns et al. 2007), and records of commercial logbooks (Cairns et al. 2012) and eel-directed research fisheries (Cairns et al. 2008).

Government and academic marine survey datasets collectively represent a huge repository of information on the fauna of eastern North American waters. Such datasets have a vast, and largely unrealized, potential to contribute to ecological understanding and marine conservation at large geographic scales. Nevertheless, interpretation of multiple survey datasets poses challenges, due to methodological differences which affect survey results in ways that are often not well quantified or understood. An additional point, often overlooked, is that survey datasets assembled from diverse sources may contain errors and anomalies that require thorough and time-consuming efforts to correct. In the present study, our data audit resulted in the discarding of about 9% of the total records received. Without careful scrutiny and editing of assembled datasets, the reliability of analytical results may be compromised.

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Table 1. Survey names, sponsors, and methods, in north-south order.

| Survey name | Survey abbreviation | Sponsor | Gear | Mesh size of net body (mm)$^a$ | Mesh size of net codend or liner (mm)$^b$ | Head-rope length (m) | Wing-spread (m) | Wing-spread: head-rope ratio | Tow duration (min) | Tow speed (km/h) | Tow distance (m) | Swept area (ha) | Source of swept area$^c$ | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Newfoundland and Labrador Trawl Survey | NL_T | Dept. Fisheries and Oceans | Yankee 41.5 trawl, 1971-1982 | 127/89 | 30 | 24.1 | 13.0 | 0.539 | 30 | 6.48 | 3,240 | 4.212 | WS | McCallum and Walsh 1997, Chadwick et al. 2007 |
| | | | Engel 145 trawl, 1977-1995, Gadus Atlantica version | 160 | 28.5 | 29.3 | 21.5 | 0.734 | 30 | 6.48 | 3,240 | 6.966 | WS | |
| | | | Engel 145 trawl, 1983-1995, Wilfred Templeman version | 150/130 | 28.5 | 29.3 | 19.5 | 0.666 | 30 | 6.48 | 3,240 | 6.318 | WS | |
| | | | Campelen 1800 trawl, 1994-2010 | 60/44 | 12.7 | 29.5 | 16.0 | 0.542 | 15 | 5.56 | 1,390 | 2.224 | WS | |
| Northern Gulf of St. Lawrence Trawl Survey | NGSL_T | Dept. Fisheries and Oceans | Engel trawl, winter 1985-1994 | 140 | 6.4 | 29.3 | 14.0 | 0.478 | 30 | 6.48 | 3,240 | 4.536 | WS | Carrothers 1988, Frechet 1990, Bourdages and Ouellet 2011 |
| | | | Western IIA trawl, 1987-1989 | 130 | 19 | 22.9 | 12.5 | 0.546 | 30 | 6.48 | 3,240 | 4.050 | WS | |
| | | | URI 24.7m/34.7m shrimp trawl, 1990-2003 | 44 | 19 | 24.7 | 13.4 | 0.543 | 24 | 5.56 | 2,224 | 2.980 | WS | |
| | | | Campelen 1800 trawl, 2004-2010 | 44 | 12.7 | 29.5 | 16.9 | 0.573 | 15 | 5.56 | 1,390 | 2.349 | WS | |
| St. Lawrence Estuary Trawl Survey | SLE_T | Société de la faune et des parcs du Québec, Dept. Fisheries and Oceans | Modified Yankee trawl | 80 | 14 | 14.6 | | | 13 | 6.52 | 1,413 | 1.217 | HR | Caron et al. 2001, Fournier 2002 |

Table 1 (continued)

| Survey name | Survey abbreviation | Sponsor | Gear | Mesh size of net body (mm)[a] | Mesh size of net codend or liner (mm)[b] | Head-rope length (m) | Wing-spread (m) | Wing-spread: head-rope ratio | Tow duration (min) | Tow speed (km/h) | Tow distance (m) | Swept area (ha) | Source of swept area[c] | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Southern Gulf of St. Lawrence Trawl Survey | SGSL_T | Dept. Fisheries and Oceans | Yankee 36 trawl, 1971-1986 | 115 | 6.4 | 18.3 | 10.7 | 0.585 | 30 | 6.48 | 3,240 | 3.500 | LIT | Carrothers 1988, Hurlbut and Clay 1990, Clark 1993, Benoit 2006, Swain et al. 2012 |
| | | | Western IIA trawl, 1987-2010 | 130 | 19 | 22.9 | 12.5 | 0.546 | 30 | 6.48 | 3,240 | 4.100 | LIT | |
| Southern Gulf of St. Lawrence Beach Seine Survey | SGSL_BS | Dept. Fisheries and Oceans | Beach seine | 6 | 6 | 30.0 | | | | | | 0.023 | B | Weldon et al. 2005 |
| Northumberland Strait Trawl Survey | NS_T | Dept. Fisheries and Oceans | No. 286 rockhopper trawl, 2000-2009 | 140 | 12 | | 9.0 | | 15 | 4.63 | 1,158 | 1.042 | WS | Hanson 2009, Swain et al. 2012, Hanson et al. 2014 |
| | | | Nephrops trawl, 2010 | 80 | 40 | | 5.9 | | 5 | 2.80 | 233 | 0.138 | WS | |
| Scotian Shelf Trawl Survey | SS_T | Dept. Fisheries and Oceans | Yankee 36 trawl, 1970-1981 | 115 | 6.4 | 18.3 | 10.7 | 0.585 | 30 | 6.48 | 3,240 | 3.467 | WS | Hurlbut and Clay 1990, Clark 1993, Chadwick et al. 2007 |
| | | | Western IIA trawl, 1978-2011 | 130 | 19 | 22.9 | 12.5 | 0.546 | 30 | 6.48 | 3,240 | 4.050 | WS | |
| Northeast Fisheries Science Center Trawl Survey | NEF_T | National Oceanic and Atmospheric Admin. | Yankee 36 trawl, 1968-2008 (except spring 1973-1981) | 114 | 12.7 | 18.3 | 12.5 | 0.683 | 30 | 6.48 | 3,240 | 3.800 | LIT | Northeast Fisheries Center 1988, NOAA 2013, Politis et al. 2014, Richardson et al. 2014 |
| | | | Yankee 41 trawl, spring 1973-1981 | 114 | 12.7 | 24.4 | 12.5 | 0.512 | 30 | 6.48 | 3,240 | 3.800 | LIT | |
| | | | 400x12 4-seam trawl, 2009-2011 | 120 | 12.7 | 24.2 | 12.8 | 0.529 | 20 | 5.56 | 1,853 | 2.400 | LIT | |

Table 1 (continued)

| Survey name | Survey abbreviation | Sponsor | Gear | Mesh size of net body (mm)[a] | Mesh size of net codend or liner (mm)[b] | Head-rope length (m) | Wing-spread (m) | Wing-spread: head-rope ratio | Tow dur-ation (min) | Tow speed (km/h) | Tow dis-tance (m) | Swept area (ha) | Source of swept area[c] | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maine and New Hampshire Trawl Survey | MENH_T | Maine Dept. Natural Resources, New Hampshire Fish and Game Dept. | Modified shrimp trawl | 50.8 | 25.4 | 17.4 | | | 20 | 4.07 | 1,357 | 1.393 | HR | Chen et al. 2006, Dunton et al. 2010 |
| Massachusetts Trawl Survey | MA_T | Massachusetts Dept. Fish and Game | North Atlantic 2 seam trawl | 89/63.5 | 12.7 | 11.9 | 8.4 | 0.706 | 20 | 4.63 | 1,543 | 1.300 | LIT | King et al. 2010, Richardson et al. 2014 |
| Northeast Area Monitoring and Assessment Program Trawl Survey | NEAMAP_T | National Oceanic and Atmospheric Admin., US Fish and Wildlife Service, Atlantic States Marine Fisheries Commission, state marine fisheries agencies | 400x12 4-seam trawl | 60/120 | 24 | 23.4 | 12.8 | 0.547 | 20 | 5.56 | 1,853 | 2.400 | LIT | Anon. 2007; Bonzek at al. 2011; Richardson et al. 2014 |
| Rhode Island Trawl Survey | RI_T | University of Rhode Island | 2 seam trawl with bag | 76 | 51 | 11.9 | 6.5 | 0.546 | 30 | 3.70 | 1,850 | 1.203 | WS | Collie et al. 2008, http://www.gso.uri.edu/fishtrawl/methods.htm |
| Long Island Sound Trawl Survey | LIS_T | Connecticut Dept. Energy and Environmental Protection | Wilcox 14 m high-rise trawl | 102 | 51 | 9.1 | 8.0 | 0.879 | 30 | 6.48 | 3,240 | 2.590 | LIT | Reid et al. 1999, Gottchall and Pacileo 2011, Richardson et al. 2014 |
| Long Island Beach Seine Survey | LI_BS | New York Dept. Environmental Conservation | Beach seine | 6.4 | 4.8 | 61.0 | | | | | | 0.093 | B | Socrates 2010 |
| Peconic Bay Trawl Survey | PB_T | New York Dept. Environmental Conservation | 4.9 m semi-balloon trawl | 38 | 13 | 5.2 | | | 10 | 4.63 | 772 | 0.237 | HR | Weber et al. 1998, US Fish and Wildlife Service 2013 |
| Long Island Atlantic Trawl Survey | LIA_T | Stony Brook University | 3:1 2 seam trawl | 120/80 | 6 | 25.0 | | | 20 | 6.02 | 2,007 | 2.961 | HR | Dunton et al. 2010 |
| Hudson Estuary Alosine Beach Seine Survey | HE_BS | New York Dept. Environmental Conservation | Beach seine | 6.4 | | 30.5 | | | | | | 0.023 | B | Kahnle and Hattala 2010, US Fish and Wildlife Service 2013 |

Table 1 (continued)

| Survey name | Survey abbreviatio | Sponsor | Gear | Mesh size of net body (mm)[a] | Mesh size of net codend or liner (mm)[b] | Head-rope length (m) | Wing-spread (m) | Wing-spread: head-rope ratio | Tow dur-ation (min) | Tow speed (km/h) | Tow dis-tance (m) | Swept area (ha) | Source of swept area[c] | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New Jersey Atlantic Trawl Survey | NJA_T | New Jersey Dept. Environmental Protection | 3:1 2 seam trawl | 120/80 | 6.4 | 25.0 | 13.0 | 0.520 | 20 | 6.02 | 2,007 | 2.408 | LIT | Dunton et al. 2010, Levesque 2013 |
| New Jersey Delaware Bay Trawl Survey | NJDB_T | New Jersey Dept. Environmental Protection | 4.9 m trawl | 38 | 13 | 5.2 | | | 10 | 3.90 | 650 | 0.199 | HR | NOAA 2012 |
| Delaware River and Delaware Bay Trawl Survey | PSEG_T | Public Service Enterprise Group | 4.9 m semi-balloon trawl | 38 | 12.7 | 5.2 | | | 10 | 6.48 | 1,080 | 0.331 | HR | PSEG 2009, 2013; Councilman et al. 2011 |
| Delaware Delaware Bay Juvenile Finfish Trawl Survey | DEDB_T | Delaware Dept. Natural Resources and Environmental Control | 4.9 m semi-balloon trawl | 38 | 12.7 | 5.2 | | | 10 | 6.48 | 1,080 | 0.331 | HR | US Fish and Wildlife Service 2013 |
| Virginia Institute of Marine Science Trawl Survey | VIMS_T | Virginia Institute of Marine Science | 9.1 m semi-balloon trawl/4.9 m trawl, 1968-1978 | 38 | 13/38 | 4.9/9.4 | | | 5/15 | | | | | Bonzek et al. 1990, Rago et al. 1995, Hata 1997, Geer 2003, Tuckey and Fabrizio 2009, ASMFC 2012 |
| | | | 9.1 m semi-balloon trawl, 1979-2011 | 38 | 6.4 | 9.4 | | | 5 | 3.70 | 308 | 0.171 | HR | |
| North Carolina Juvenile Trawl Survey (P120) | NCJUV_T | North Carolina Dept. Environmental and Natural Resources | 2 seam trawl | 6.4 | 3.2 | 3.2 | | | 1 | 4.11 | 69 | 0.013 | HR | DeVries 1985, NMFS 2006 |
| North Carolina Adult Trawl survey (P195) | NCAD_T | North Carolina Dept. Environmental and Natural Resources | Paired mongoose falcon trawls | 22 | 19 | 9.1 | | | 20 | 4.63 | 1,543 | 1.630 | LIT | NMFS 2006, Rock and Knight 2012 |

**Table 1 (continued)**

| Survey name | Survey abbreviation | Sponsor | Gear | Mesh size of net body (mm)[a] | Mesh size of net codend or liner (mm)[b] | Head-rope length (m) | Wing-spread (m) | Wing-spread: head-rope ratio | Tow dur-ation (min) | Tow speed (km/h) | Tow dis-tance (m) | Swept area (ha) | Source of swept area[c] | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Southeast Area Monitoring and Assessment Program (South Atlantic) Trawl Survey | SEAMAP_T | National Oceanic and Atmospheric Admin., US Fish and Wildlife Service, Atlantic States Marine Fisheries Commission, state marine fisheries agencies | Paired mongoose falcon trawls | 47.6 | 41.3 | 26.3 | | | 20 | 4.63 | 1,543 | 4.791 | HR | Richardson et al. 2014 |
| Georgia Trawl Survey | GA_T | Georgia Dept. Natural Resources | 12.2 m flat trawl | 48 | 48 | 11.0 | | | 15 | 4.17 | 1,043 | 0.677 | HR | Belcher and Jennings 2009; J. Page, GA Dept. Natural Resources, pers. comm. |
| Mean | | | | 72.8 | 18.6 | 20.2 | 12.5 | 0.590 | 20.5 | 5.49 | 1,978 | 2.268 | | |
| SD | | | | 47.4 | 13.3 | 11.2 | 3.8 | 0.096 | 9.0 | 1.11 | 1,059 | 1.866 | | |
| Min | | | | 6 | 3.2 | 3.2 | 5.9 | 0.478 | 1 | 2.80 | 69 | 0.013 | | |
| Max | | | | 160 | 51 | 61 | 21.5 | 0.879 | 30 | 6.52 | 3,240 | 6.966 | | |
| N | | | | 31 | 36 | 35 | 22 | 20 | 34 | 34 | 34 | 37 | | |

[a] For beach seines, the value indicates mesh size in the main panels.

[b] For beach seines, the value indicates mesh size in the bunt or bag.

[c] B, applying to beach seines, means that swept area is calculated as (Headrope length/2)$^2$, which is based on the assumption that the net is brought from shore into the water to 1/2 its length, then parallel to the shore for the same distance, and then back to shore (Weldon et al. 2005). HR means that swept area is calculated as Headrope length x 0.59 x Tow distance, where 0.59 is the mean ratio of wingspread to headrope length (from this table). LIT means that swept area is from the cited literature. WS means that swept area is calculated as Wingspread x Tow distance.

Table 2. Number of sets in surveys by Waterbody and by River.

| Survey | Total number of sets | Number of sets in Waterbody | | | | | | | | | | | | | | Number of sets in River | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Canadian Atlantic | Gulf of St. Lawrence | St. Lawrence Estuary | US Atlantic | Hudson Tidal Fresh | Hudson Saline | Del. River Tidal Fresh | Del. River Saline | Del. Bay Proper | Ches. Tribs Fresh | Ches. Tribs Saline | Ches. Bay Proper | Albemarle | Pamlico | Hudson | Delaware | Potomac | Rappahannock | York | James |
| NL_T | 41,636 | 41,617 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NGSL_T | 6,613 | 587 | 5,674 | 352 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SLE_T | 187 | 0 | 0 | 187 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGSL_T | 5,880 | 76 | 5,804 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SGSL_BS | 6,423 | 0 | 6,423 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NS_T | 2,573 | 0 | 2,573 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SS_T | 13,792 | 12,477 | 8 | 0 | 1,307 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEF_T | 32,159 | 4,204 | 0 | 0 | 27,916 | 0 | 0 | 0 | 0 | 28 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MENH_T | 2,068 | 31 | 0 | 0 | 2,037 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MA_T | 6,348 | 0 | 0 | 0 | 6,348 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NEAMAP_T | 1,519 | 0 | 0 | 0 | 1,517 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RI_T | 5,274 | 0 | 0 | 0 | 5,274 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LIS_T | 5,966 | 0 | 0 | 0 | 5,966 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LI_BS | 4,234 | 0 | 0 | 0 | 4,234 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PB_T | 7,811 | 0 | 0 | 0 | 7,811 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LIA_T | 543 | 0 | 0 | 0 | 543 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| HE_BS | 12,820 | 0 | 0 | 0 | 0 | 3,736 | 9,084 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12,820 | 0 | 0 | 0 | 0 | 0 |
| NJA_T | 4,427 | 0 | 0 | 0 | 4,412 | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NJDB_T | 1,549 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 132 | 1,417 | 0 | 0 | 0 | 0 | 0 | 0 | 132 | 0 | 0 | 0 | 0 |
| PSEG_T | 4,881 | 0 | 0 | 0 | 0 | 0 | 0 | 565 | 1,539 | 2,777 | 0 | 0 | 0 | 0 | 0 | 0 | 2,104 | 0 | 0 | 0 | 0 |
| DEDB_T | 8,059 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,948 | 4,111 | 0 | 0 | 0 | 0 | 0 | 0 | 3,948 | 0 | 0 | 0 | 0 |
| VIMS_T | | | | | | | | | | | | | | | | | | | | | |
| 1968-1978 | 7,309 | 0 | 0 | 0 | 32 | 0 | 0 | 0 | 0 | 0 | 720 | 5,520 | 1,037 | 0 | 0 | 0 | 0 | 247 | 1,482 | 2,620 | 1,552 |
| 1979-2011 | 28,533 | 0 | 0 | 0 | 136 | 0 | 0 | 0 | 0 | 0 | 1,262 | 17,246 | 9,889 | 0 | 0 | 0 | 0 | 197 | 5,683 | 6,149 | 6,014 |
| 1968-2011 | 35,842 | 0 | 0 | 0 | 168 | 0 | 0 | 0 | 0 | 0 | 1,982 | 22,766 | 10,926 | 0 | 0 | 0 | 0 | 444 | 7,165 | 8,769 | 7,566 |
| NCJUV_T | 24,001 | 0 | 0 | 0 | 5,266 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,666 | 17,069 | 0 | 0 | 0 | 0 | 0 | 0 |
| NCAD_T | 3,200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 3,152 | 0 | 0 | 0 | 0 | 0 | 0 |
| SEAMAP_T | 6,754 | 0 | 0 | 0 | 6,754 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GA_T | 4,210 | 0 | 0 | 0 | 4,210 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 248,769 | 58,992 | 20,501 | 539 | 83,763 | 3,736 | 9,084 | 565 | 5,619 | 8,350 | 1,982 | 22,766 | 10,937 | 1,714 | 20,221 | 12,820 | 6,184 | 444 | 7,165 | 8,769 | 7,566 |
| Percent[a] | 100.0 | 23.7 | 8.2 | 0.2 | 33.7 | 1.5 | 3.7 | 0.2 | 2.3 | 3.4 | 0.8 | 9.2 | 4.4 | 0.7 | 8.1 | 29.9 | 14.4 | 1.0 | 16.7 | 20.4 | 17.6 |

[a] For Waterbodies, based on the total number of sets; for Rivers, based on the number of sets classified by River (42,948).

Table 3. Eel catches in surveys.

| Survey | Total eels caught | Total number of sets | Eels caught per set | | | | Sets that caught eels | |
|---|---|---|---|---|---|---|---|---|
| | | | Mean | SD | Min | Max | Number | Percent |
| NL_T | 0 | 41,636 | 0.0000 | 0.0000 | 0 | 0 | 0 | 0.000 |
| NGSL_T | 0 | 6,613 | 0.0000 | 0.0000 | 0 | 0 | 0 | 0.000 |
| SLE_T | 10 | 187 | 0.0535 | 0.2256 | 0 | 1 | 10 | 5.348 |
| SGSL_T | 1 | 5,880 | 0.0002 | 0.0130 | 0 | 1 | 1 | 0.017 |
| SGSL_BS | 524 | 6,423 | 0.0816 | 3.1776 | 0 | 252 | 168 | 2.616 |
| NS_T | 0 | 2,573 | 0.0000 | 0.0000 | 0 | 0 | 0 | 0.000 |
| SS_T | 9 | 13,792 | 0.0007 | 0.0390 | 0 | 3 | 5 | 0.036 |
| NEF_T | 55 | 32,159 | 0.0017 | 0.1149 | 0 | 16 | 24 | 0.075 |
| MENH_T | 5 | 2,068 | 0.0024 | 0.0491 | 0 | 1 | 5 | 0.242 |
| MA_T | 18 | 6,348 | 0.0028 | 0.0753 | 0 | 4 | 13 | 0.205 |
| NEAMAP_T | 25 | 1,519 | 0.0165 | 0.2978 | 0 | 8 | 9 | 0.592 |
| RI_T | 16 | 5,274 | 0.0030 | 0.0645 | 0 | 3 | 14 | 0.265 |
| LIS_T | 10 | 5,966 | 0.0017 | 0.0448 | 0 | 2 | 9 | 0.151 |
| LI_BS | 499 | 4,234 | 0.1179 | 1.1710 | 0 | 34 | 162 | 3.826 |
| PB_T | 22 | 7,811 | 0.0028 | 0.0576 | 0 | 2 | 20 | 0.256 |
| LIA_T | 9 | 543 | 0.0166 | 0.1540 | 0 | 2 | 7 | 1.289 |
| HE_BS | 4,158 | 12,820 | 0.3243 | 1.1009 | 0 | 40 | 2,185 | 17.044 |
| NJA_T | 39 | 4,427 | 0.0088 | 0.1581 | 0 | 8 | 27 | 0.610 |
| NJDB_T | 39 | 1,549 | 0.0252 | 0.1798 | 0 | 2 | 33 | 2.130 |
| PSEG_T | | | | | | | | |
| River | 2,482 | 2,104 | 1.1797 | 5.275847 | 0 | 174 | 657 | 31.226 |
| Non-River | 17 | 2,777 | 0.0061 | 0.115287 | 0 | 5 | 13 | 0.468 |
| Overall | 2,499 | 4,881 | 0.5120 | 3.5129 | 0 | 174 | 670 | 13.727 |
| DEDB_T | 6,385 | 8,059 | 0.7923 | 3.8211 | 0 | 118 | 1,508 | 18.712 |
| VIMS_T | | | | | | | | |
| River | NA | 24,748 | NA | NA | NA | NA | 4,540 | 18.345 |
| Non-River | NA | 11,094 | NA | NA | NA | NA | 66 | 0.595 |
| 1968-1978 | NA | 7,309 | NA | NA | NA | NA | 1,228 | 16.801 |
| 1979-2011 | NA | 28,533 | NA | NA | NA | NA | 3,378 | 11.839 |
| Overall | NA | 35,842 | NA | NA | NA | NA | 4,606 | 12.851 |
| NCJUV_T | 1,469 | 24,001 | 0.0612 | 0.4166 | 0 | 28 | 1,222 | 5.091 |
| NCAD_T | 14 | 3,200 | 0.0044 | 0.0660 | 0 | 1 | 14 | 0.438 |
| SEAMAP_T | 0 | 6,754 | 0.0000 | 0.0000 | 0 | 0 | 0 | 0.000 |
| GA_T | 3 | 4,210 | 0.0007 | 0.0267 | 0 | 1 | 3 | 0.071 |
| Total | 15,809 | 248,769 | 0.0742 | 1.1381 | 0 | 252 | 10,715 | 4.307 |

Table 4. Yellow eel catch rates, area swept, yellow eels caught per area swept, and catchable eels in survey areas.

| Survey | Eel phase captured[a] | Mean yellow eels caught per set | % of sets that caught yellow eels | Area swept per set (ha) | Yellow eels caught per area swept (eels/ha) | Survey area ($km^2$) | Catchable yellow eels in survey area[b] | Eel density from literature (eels/ha) |
|---|---|---|---|---|---|---|---|---|
| NL_T | | | | | | | | |
| Yankee 41.5 | N | 0.00000 | 0.00000 | 4.2120 | 0.0000 | 812,071 | 0 | |
| Engel 145, G. Atlantica | N | 0.00000 | 0.00000 | 6.9660 | 0.0000 | 812,071 | 0 | |
| Engel 145, W. Templeman | N | 0.00000 | 0.00000 | 6.3180 | 0.0000 | 812,071 | 0 | |
| Campelen 1800 | N | 0.00000 | 0.00000 | 2.2240 | 0.0000 | 812,071 | 0 | |
| NGSL_T | | | | | | | | |
| Engel | N | 0.00000 | 0.00000 | 4.5360 | 0.0000 | 154,206 | 0 | |
| Western IIA | N | 0.00000 | 0.00000 | 4.0500 | 0.0000 | 154,206 | 0 | |
| URI | N | 0.00000 | 0.00000 | 2.9802 | 0.0000 | 154,206 | 0 | |
| Campelen 1800 | N | 0.00000 | 0.00000 | 2.3491 | 0.0000 | 154,206 | 0 | |
| SLE_T | S | 0.00000 | 0.00000 | 1.2173 | 0.0000 | 187 | 0 | |
| SGSL_T | | | | | | | | |
| Yankee 36 | N | 0.00000 | 0.00000 | 3.5000 | 0.0000 | 70,061 [c] | 0 | |
| Western IIA | S | 0.00000 | 0.00000 | 4.1000 | 0.0000 | 73,182 [c] | 0 | |
| SGSL_BS | Y,E | 0.03456 [d] | 2.44434 [e] | 0.0225 | 1.5361 | NA | | 75.6 [f] |
| NS_T | | | | | | | | |
| 286 Rockhopper | N | 0.00000 | 0.00000 | 1.0418 | 0.0000 | 15,834 | 0 | |
| Nephrops | N | 0.00000 | 0.00000 | 0.1377 | 0.0000 | 15,834 | 0 | |
| SS_T | | | | | | | | |
| Yankee 36 | N | 0.00000 | 0.00000 | 3.4668 | 0.0000 | 292,206 | 0 | |
| Western IIA | Y | 0.00074 | 0.04129 | 4.0500 | 0.0002 | 292,206 | 5,363 | |
| NEF_T | | | | | | | | |
| Yankee 36 | Y | 0.00209 | 0.09099 | 3.8000 | 0.0005 | 429,254 | 23,555 | |
| Yankee 41 | N | 0.00000 | 0.00000 | 3.8000 | 0.0000 | 429,254 | 0 | |
| 4-seam | N | 0.00000 | 0.00000 | 2.4000 | 0.0000 | 429,254 | 0 | |
| MENH_T | Y | 0.00242 | 0.24178 | 1.3932 | 0.0017 | 16,945 | 2,941 | |
| MA_T | Y | 0.00284 | 0.20479 | 1.3000 | 0.0022 | 7,043 | 1,536 | |
| NEAMAP_T | S | 0.00000 | 0.00000 | 2.4000 | 0.0000 | 16,593 | 0 | |
| RI_T | Y | 0.00303 | 0.26545 | 1.2025 | 0.0025 | 73 | 18 | |
| LIS_T | Y | 0.00168 | 0.15085 | 2.5900 | 0.0006 | 3,033 | 196 | |
| LI_BS | Y | 0.11786 | 3.82617 | 0.0930 | 1.2669 | NA | | |
| PB_T | Y | 0.00282 | 0.25605 | 0.2368 | 0.0119 | 179 | 213 | |
| LIA_T | Y | 0.01657 | 1.28913 | 2.9608 | 0.0056 | 3,066 | 1,716 | |
| HE_BS | Y | 0.32434 | 17.04368 | 0.0233 | 13.9462 | 266 | 370,970 | 9.5 [g] |
| NJA_T | Y | 0.00881 | 0.60989 | 2.4076 | 0.0037 | 5,988 | 2,191 | |
| NJDB_T | Y | 0.02518 | 2.13041 | 0.1995 | 0.1262 | 163 | 2,057 | |
| PSEG_T | | | | | | | | |
| River | Y | 1.17966 | 31.22624 | 0.3315 | 3.5591 | 458 | 163,006 | |
| Non-River | Y | 0.00612 | 0.46813 | 0.3315 | 0.0185 | 1,576 | 2,911 | |
| Overall | Y | 0.51199 | 13.72670 | 0.3315 | 1.5447 | 2,034 | 314,188 | |
| DEDB_T | Y | 0.79228 | 18.71200 | 0.3315 | 2.3903 | 360 | 86,053 | |
| VIMS_T, 1979-2011 | | | | | | | | |
| River | Y | NA | 17.95980 | 0.1711 | 1.0499 [h] | 2,932 | 307,841 | 84.5 [i] |
| Non-River | Y | NA | 0.53865 | 0.1711 | 0.0315 [h] | 3,364 | 10,593 | |
| Overall | Y | NA | 11.83892 | 0.1711 | 0.6921 [h] | 6,296 | 435,750 | |
| NCJUV_T | Y,E | 0.05330 [j] | 4.52064 | 0.0129 | 4.1198 | 3,655 | 1,505,797 | |
| NCAD_T | Y | 0.00438 | 0.43750 | 1.6304 | 0.0027 | 4,778 | 1,282 | |
| SEAMAP_T | N | 0.00000 | 0.00000 | 4.7911 | 0.0000 | 27,041 | 0 | |
| GA_T | Y | 0.00071 | 0.07126 | 0.6768 | 0.0011 | 15,856 | 1,669 | |

Table 4 (continued)

[a] Y=yellow, S=silver, E=elver, N=no eels captured. A silver phase is assumed for eels captured in SLE_T and SGSL_T (based on capture timing and size) and NEAMAP_T (based on capture timing). In SGSL_BS and NCJUV_T, eels $\leq$9 cm were classed as elvers and eels >9 cm were classed as yellow. All other eels were classed as yellow.

[b] Estimated as Yellow eels caught per area swept x Survey area.

[c] Survey area was 70,061 $km^2$ for 1971-1983 and 73,182 $km^2$ for 1984-2010.

[d] Based on 222 eels, >9 cm long, captured in 6,423 sets.

[e] Based on 157 sets which caught 1 or more eels >9 cm, of a total of 6,423 sets.

[f] For southern Gulf of St. Lawrence bays and estuaries, from glass bottom boat surveys (Hallett 2013).

[g] For the Hudson tidal estuary, from capture-mark-recapture analysis (Morrison and Secor 2004).

[h] Our dataset does not include the number of eels caught per set. It is here assumed that 1 eel was caught in each set that caught eels. The true mean number of eels caught per set is likely to be higher than this.

[i] Based on the mean of annual estimates for 1980-2008 of the number of age 4+ eels in the Potomac River estuary derived from an age- and sex-structured model (Fenske et al. 2011), divided by the area of the Potomac's tidal estuary (1,182 $km^2$).

[j] The number of yellow eels caught was estimated from the proportion (0.8708) of eels >9 cm long in a measured sample of the catch (N=1,742).

Table 5. Timing of surveys.

| Survey | Year | | Month | | | | Time of day | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min | Max | Mean | SD | Min | Max | Mean | SD | Min | Max | N |
| NL_T | 1971 | 2010 | 7.6 | 3.4 | 1 | 12 | 12:05 | 6:51 | 0:00 | 23:59 | 41,590 |
| NGSL_T | 1985 | 2010 | 6.5 | 3.0 | 1 | 9 | 12:02 | 6:55 | 0:00 | 23:59 | 6,610 |
| SLE_T | 2000 | 2001 | 8.1 | 0.8 | 6 | 9 | 12:40 | 2:53 | 6:44 | 18:55 | 185 |
| SGSL_T[a] | 1971 | 2010 | 9.0 | 0.1 | 8 | 11 | 12:21 | 6:16 | 0:00 | 23:59 | 5,873 |
| SGSL_BS | 2004 | 2012 | 7.0 | 1.3 | 5 | 9 | Day only | | | | |
| NS_T | 2000 | 2010 | 7.7 | 1.0 | 5 | 10 | 12:11 | 3:06 | 0:00 | 20:50 | 2,572 |
| SS_T | 1970 | 2011 | 5.6 | 2.5 | 2 | 12 | 12:03 | 6:54 | 0:01 | 23:59 | 13,671 |
| NEF_T | 1963 | 2011 | 6.9 | 3.2 | 2 | 12 | 12:04 | 6:57 | 0:00 | 23:59 | 32,128 |
| MENH_T | 2000 | 2011 | 7.3 | 2.6 | 4 | 12 | 11:37 | 2:47 | 5:51 | 19:00 | 2,068 |
| MA_T | 1978 | 2011 | 6.9 | 2.0 | 4 | 10 | 11:01 | 3:03 | 4:21 | 19:04 | 6,348 |
| NEAMAP_T | 2007 | 2012 | 7.2 | 2.7 | 4 | 10 | 12:54 | 3:51 | 5:56 | 21:37 | 1,519 |
| RI_T | 1959 | 2012 | 6.5 | 3.4 | 1 | 12 | 9:52 | 1:11 | 6:30 | 16:00 | 982 |
| LIS_T | 1984 | 2011 | 7.2 | 2.3 | 4 | 12 | Day only | | | | |
| LI_BS | 1984 | 2011 | 7.1 | 1.8 | 4 | 11 | | | | | |
| PB_T | 1987 | 2010 | 7.5 | 1.7 | 4 | 11 | Day only | | | | |
| LIA_T | 2005 | 2007 | 6.6 | 3.1 | 1 | 11 | 11:47 | 3:19 | 6:13 | 19:29 | 542 |
| HE_BS | 1980 | 2009 | 8.6 | 1.3 | 6 | 11 | 11:50 | 2:27 | 5:40 | 21:03 | 12,784 |
| NJA_T | 1988 | 2012 | 6.2 | 3.0 | 1 | 12 | 12:37 | 3:24 | 5:43 | 20:47 | 4,427 |
| NJDB_T | 1991 | 2011 | 7.1 | 2.0 | 4 | 11 | | | | | |
| PSEG_T | 1998 | 2010 | 7.4 | 2.2 | 4 | 12 | 12:53 | 2:32 | 0:26 | 19:30 | 4,881 |
| DEDB_T | 1978 | 2009 | 7.1 | 2.0 | 4 | 10 | | | | | |
| VIMS_T | | | | | | | | | | | |
| 1968-1978[a] | 1968 | 1978 | 5.9 | 3.1 | 1 | 12 | Day only | | | | |
| 1979-2011 | 1979 | 2011 | 6.7 | 3.4 | 1 | 12 | Day only | | | | |
| 1968-2011 | 1968 | 2011 | 6.6 | 3.3 | 1 | 12 | Day only | | | | |
| NCJUV_T | 1973 | 2010 | 6.6 | 2.4 | 1 | 12 | Day only | | | | |
| NCAD_T | 1987 | 2013 | 7.4 | 2.1 | 1 | 12 | 12:27 | 2:50 | 2:32 | 20:04 | 3,197 |
| SEAMAP_T | 1989 | 2011 | 7.2 | 2.4 | 4 | 11 | 12:24 | 3:25 | 0:02 | 23:51 | 6,754 |
| GA_T | 2003 | 2011 | 6.6 | 3.4 | 1 | 12 | 11:34 | 2:42 | 2:08 | 20:25 | 4,106 |
| Total | 1959 | 2013 | 7.1 | 2.9 | 1 | 12 | 12:03 | 5:51 | 0:00 | 23:59 | 150,325 |

[a] Survey was day only until 1985

[b] The VIMS_T series began in 1955. Data for 1968-2011 were available for this report.

Table 6. Percent of sets with eels and mean eels per set in surveys which include >150 sets that caught eels.

| Year | Southern Gulf of St. Lawrence, NB, NS, PE, beach seine, SGSL_BS[ab] | | Long Island, NY, beach seine, LI_BS | | Hudson Estuary, NY, beach seine, HE_BS | | Delaware River and Bay, DE, NJ, trawl, PSEG_T | | Delaware River and Bay, PA, DE, NJ, trawl DEDB_T | |
|---|---|---|---|---|---|---|---|---|---|---|
| | % sets with eels | Mean eels/set | % sets with eels | Mean eels/set | % sets with eels | Mean eels/set | % sets with eels | Mean eels/set | % sets with eels | Mean eels/set |
| 1973 | | | | | | | | | | |
| 1974 | | | | | | | | | | |
| 1975 | | | | | | | | | | |
| 1976 | | | | | | | | | | |
| 1977 | | | | | | | | | | |
| 1978 | | | | | | | | | 0.000 | 0.000 |
| 1979 | | | | | | | | | 0.000 | 0.000 |
| 1980 | | | | | 10.849 | 0.274 | | | 15.301 | 0.601 |
| 1981 | | | | | 24.752 | 0.525 | | | 25.000 | 2.696 |
| 1982 | | | | | 27.053 | 0.609 | | | 23.651 | 1.295 |
| 1983 | | | | | 18.482 | 0.462 | | | 18.565 | 0.992 |
| 1984 | | | 18.056 | 0.778 | 16.721 | 0.472 | | | 23.770 | 0.750 |
| 1985 | | | 15.000 | 0.300 | 26.667 | 0.556 | | | 11.712 | 0.261 |
| 1986 | | | 13.534 | 0.541 | 27.527 | 0.581 | | | 10.417 | 0.333 |
| 1987 | | | 6.522 | 0.304 | 21.393 | 0.575 | | | 7.018 | 0.149 |
| 1988 | | | 13.714 | 0.560 | 21.622 | 0.570 | | | 7.627 | 0.314 |
| 1989 | | | 10.563 | 0.246 | 19.874 | 0.387 | | | 12.551 | 0.381 |
| 1990 | | | 3.361 | 0.059 | 19.822 | 0.394 | | | 12.563 | 0.226 |
| 1991 | | | 1.709 | 0.026 | 13.717 | 0.305 | | | 15.185 | 0.415 |
| 1992 | | | 2.778 | 0.037 | 20.215 | 0.333 | | | 21.300 | 0.957 |
| 1993 | | | 3.333 | 0.033 | 12.397 | 0.196 | | | 20.939 | 0.531 |
| 1994 | | | 3.788 | 0.076 | 15.258 | 0.245 | | | 19.355 | 0.774 |
| 1995 | | | 0.000 | 0.000 | 15.296 | 0.245 | | | 20.357 | 0.707 |
| 1996 | | | 3.125 | 0.094 | 18.066 | 0.270 | | | 28.674 | 0.946 |
| 1997 | | | 0.000 | 0.000 | 11.111 | 0.224 | | | 24.643 | 2.121 |
| 1998 | | | 2.174 | 0.022 | 17.684 | 0.265 | 5.859 | 0.201 | 19.713 | 1.022 |
| 1999 | | | 0.840 | 0.008 | 17.156 | 0.343 | 11.250 | 0.638 | 23.929 | 1.536 |
| 2000 | | | 2.597 | 0.032 | 14.017 | 0.215 | 9.091 | 0.220 | 15.356 | 0.487 |
| 2001 | | | 1.081 | 0.011 | 12.615 | 0.216 | 12.868 | 0.934 | 18.638 | 0.978 |
| 2002 | | | 1.667 | 0.033 | 20.920 | 0.382 | 13.143 | 0.415 | 20.000 | 0.586 |
| 2003 | | | 2.857 | 0.143 | 15.745 | 0.232 | 25.417 | 1.007 | 21.168 | 0.580 |
| 2004 | 4.215 | 0.061 | 3.109 | 0.031 | 19.068 | 0.318 | 16.211 | 0.443 | 25.275 | 1.824 |
| 2005 | 4.348 | 0.063 | 1.724 | 0.029 | 8.316 | 0.120 | 14.968 | 0.643 | 29.304 | 1.000 |
| 2006 | 1.900 | 0.029 | 0.541 | 0.005 | 10.064 | 0.150 | 12.342 | 0.377 | 22.711 | 0.571 |
| 2007 | 2.304 | 0.035 | 0.472 | 0.009 | 12.527 | 0.221 | 12.579 | 0.503 | 20.147 | 0.575 |
| 2008 | 3.030 | 0.041 | 0.000 | 0.000 | 15.400 | 0.240 | 12.893 | 0.434 | 18.681 | 0.447 |
| 2009 | 1.874 | 0.028 | 0.490 | 0.005 | 15.011 | 0.192 | 14.151 | 0.525 | 23.810 | 0.612 |
| 2010 | 2.062 | 0.031 | 1.026 | 0.010 | | | 12.025 | 0.285 | | |
| 2011 | 1.400 | 0.016 | 0.943 | 0.009 | | | | | | |
| 2012 | 1.939 | 0.023 | | | | | | | | |
| Correlation[c] | | | | | | | | | | |
| r | | 0.985 | | 0.941 | | 0.887 | | 0.727 | | 0.683 |
| P | | <0.0001 | | <0.0001 | | <0.0001 | | 0.005 | | <0.0001 |

Table 6 (continued)

| Year | Rappahannock R., VA, trawl, VIMS_T, % sets with eels | York R., VA, trawl, VIMS_T, % sets with eels | James R., VA, trawl, VIMS_T, % sets with eels | Rappahannock, York, and James Rivers, VA, trawl, VIMS_T, % sets with eels | Coastal sounds, NC, trawl, NCJUV_T | |
|---|---|---|---|---|---|---|
| | | | | | % sets with eels | Mean eels/set |
| 1973 | | | | | 4.750 | 0.054 |
| 1974 | | | | | 1.907 | 0.021 |
| 1975 | | | | | 2.919 | 0.029 |
| 1976 | | | | | 4.009 | 0.040 |
| 1977 | | | | | 3.072 | 0.031 |
| 1978 | | | | | 9.144 | 0.151 |
| 1979 | 20.472 | 22.845 | 29.167 | 24.875 | 8.168 | 0.177 |
| 1980 | 23.596 | 44.366 | 33.043 | 35.260 | 6.094 | 0.131 |
| 1981 | 30.769 | 39.310 | 34.513 | 35.714 | 7.802 | 0.078 |
| 1982 | 32.407 | 50.000 | 26.623 | 36.715 | 4.864 | 0.049 |
| 1983 | 31.395 | 40.132 | 33.871 | 35.912 | 3.857 | 0.039 |
| 1984 | 49.206 | 57.500 | 45.641 | 50.000 | 4.762 | 0.049 |
| 1985 | 32.308 | 44.660 | 33.028 | 37.184 | 3.464 | 0.035 |
| 1986 | 35.849 | 31.132 | 35.088 | 34.049 | 3.083 | 0.031 |
| 1987 | 27.273 | 32.653 | 33.721 | 31.250 | 3.529 | 0.037 |
| 1988 | 9.901 | 23.148 | 21.053 | 18.092 | 5.448 | 0.055 |
| 1989 | 18.400 | 16.535 | 28.302 | 20.670 | 5.712 | 0.057 |
| 1990 | 22.689 | 24.800 | 26.852 | 24.716 | 10.922 | 0.114 |
| 1991 | 20.000 | 17.829 | 13.761 | 17.318 | 6.170 | 0.064 |
| 1992 | 12.000 | 13.600 | 25.225 | 16.620 | 9.429 | 0.102 |
| 1993 | 11.811 | 12.403 | 22.523 | 15.259 | 5.263 | 0.053 |
| 1994 | 19.200 | 13.953 | 21.622 | 18.082 | 7.237 | 0.076 |
| 1995 | 20.213 | 15.238 | 31.250 | 22.034 | 3.235 | 0.032 |
| 1996 | 22.179 | 18.725 | 32.895 | 24.321 | 6.793 | 0.082 |
| 1997 | 25.660 | 17.803 | 27.547 | 23.678 | 3.419 | 0.037 |
| 1998 | 20.313 | 16.858 | 26.792 | 21.355 | 4.561 | 0.046 |
| 1999 | 12.879 | 12.121 | 25.455 | 16.936 | 7.560 | 0.086 |
| 2000 | 18.113 | 10.646 | 18.613 | 15.835 | 2.556 | 0.026 |
| 2001 | 11.255 | 14.159 | 19.214 | 14.869 | 5.296 | 0.053 |
| 2002 | 7.955 | 11.494 | 18.939 | 12.801 | 4.375 | 0.044 |
| 2003 | 14.015 | 7.308 | 17.045 | 12.817 | 5.325 | 0.053 |
| 2004 | 13.258 | 7.280 | 12.121 | 10.900 | 5.042 | 0.050 |
| 2005 | 7.576 | 4.580 | 11.610 | 7.945 | 5.205 | 0.055 |
| 2006 | 3.774 | 3.462 | 8.678 | 5.215 | 5.038 | 0.050 |
| 2007 | 5.682 | 7.576 | 6.415 | 6.557 | 3.077 | 0.031 |
| 2008 | 12.500 | 10.728 | 10.227 | 11.153 | 3.385 | 0.034 |
| 2009 | 10.227 | 9.615 | 10.985 | 10.279 | 3.211 | 0.032 |
| 2010 | 11.742 | 12.692 | 6.792 | 10.393 | 4.505 | 0.045 |
| 2011 | | | | | | |
| 2012 | | | | | | |
| Correlation[c] | | | | | | |
| r | | | | | | 0.850 |
| P | | | | | | <0.0001 |

[a] Header gives location, province/state, gear, and the survey abbreviation.

[b] Excludes elvers

[c] Correlation between % of sets with eels and mean eels per set.

Table 7. Depth, distance to land, fetch, and adjusted fetch of set locations.

| Survey | Number of sets | Number of set locations[a] | Mean number of sets per location | Depth of sets (m) | | | | | Distance of set to nearest land (km) | | | | Mean fetch (km) | | | | Mean adjusted fetch (km) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | SD | Min | Max | N | Mean | SD | Min | Max | Mean | SD | Min | Max | Mean | SD | Min | Max |
| NL_T | 41,636 | 41,530 | 1.0 | 270.4 | 241.2 | 32.0 | 1,605.0 | 41,579 | 204.6 | 140.5 | 1.3 | 676.2 | 524.7 | 105.8 | 6.7 | 650.0 | 491.8 | 129.3 | 10.3 | 650.0 |
| NGSL_T | 6,613 | 6,610 | 1.0 | 253.6 | 109.4 | 30.0 | 525.0 | 6,605 | 37.0 | 22.7 | 1.5 | 135.3 | 186.7 | 68.2 | 40.9 | 444.9 | 196.9 | 71.0 | 42.0 | 437.1 |
| SLE_T | 187 | 187 | 1.0 | 10.9 | 3.8 | 4.7 | 25.2 | 185 | 2.1 | 0.9 | 0.4 | 5.9 | 10.7 | 3.4 | 5.6 | 22.1 | 12.4 | 3.9 | 5.6 | 26.5 |
| SGSL_T | 5,880 | 5,486 | 1.1 | 81.3 | 69.2 | 13.0 | 386.0 | 5,877 | 33.1 | 23.1 | 0.9 | 104.6 | 166.6 | 60.4 | 23.8 | 426.6 | 143.0 | 57.3 | 19.3 | 404.1 |
| SGSL_BS | 6,423 | 232 | 27.7 | | | | | | 0.0 | 0.0 | 0.0 | 0.1 | 2.7 | 4.8 | 0.1 | 31.5 | 2.3 | 3.7 | 0.1 | 24.1 |
| NS_T | 2,573 | 2,572 | 1.0 | 18.2 | 9.4 | 3.0 | 66.0 | 2,570 | 8.2 | 4.8 | 0.4 | 30.1 | 51.1 | 29.3 | 10.2 | 154.9 | 42.2 | 21.0 | 9.2 | 153.3 |
| SS_T | 13,792 | 12,969 | 1.1 | 69.9 | 38.8 | 11.0 | 210.0 | 6,473 | 99.4 | 58.8 | 1.0 | 276.8 | 438.9 | 102.0 | 41.3 | 561.9 | 436.1 | 104.9 | 34.4 | 560.3 |
| NEF_T | 32,159 | 28,527 | 1.1 | 92.0 | 75.7 | 5.0 | 516.0 | 32,129 | 77.8 | 64.9 | 0.0 | 285.5 | 378.6 | 101.3 | 0.1 | 566.6 | 343.8 | 111.9 | 0.1 | 551.9 |
| MENH_T | 2,068 | 2,066 | 1.0 | 39.9 | 19.5 | 2.5 | 108.0 | 2,068 | 8.2 | 7.2 | 0.0 | 32.6 | 179.4 | 73.2 | 2.5 | 289.3 | 144.3 | 63.0 | 2.1 | 245.8 |
| MA_T | 6,348 | 6,337 | 1.0 | 23.2 | 16.4 | 4.0 | 86.0 | 6,346 | 4.9 | 3.7 | 0.0 | 17.2 | 134.6 | 88.8 | 5.5 | 365.3 | 112.3 | 75.6 | 4.9 | 333.5 |
| NEAMAP_T | 1,519 | 1,515 | 1.0 | 53.0 | 26.4 | 12.0 | 188.0 | 1,518 | 7.5 | 5.5 | 0.6 | 28.7 | 270.7 | 47.8 | 16.7 | 433.2 | 218.6 | 45.9 | 17.0 | 458.1 |
| RI_T | 5,274 | 2 | 2637.0 | 14.9 | 8.0 | 7.0 | 22.9 | 5,274 | 0.9 | 0.3 | 0.6 | 1.2 | 95.2 | 73.4 | 22.3 | 169.0 | 71.5 | 50.5 | 21.3 | 122.3 |
| LIS_T | 5,966 | 4,285 | 1.4 | | | | | | 5.7 | 3.8 | 0.0 | 15.3 | 26.2 | 8.7 | 4.5 | 73.7 | 25.6 | 6.7 | 4.1 | 61.3 |
| LI_BS | 4,234 | 128 | 33.1 | | | | | | 0.0 | 0.1 | 0.0 | 3.1 | 0.9 | 1.2 | 0.0 | 61.2 | 1.0 | 1.3 | 0.0 | 67.9 |
| PB_T | 7,811 | 72 | 108.5 | 5.4 | 2.2 | 0.0 | 15.2 | 7,811 | 1.1 | 0.9 | 0.0 | 3.7 | 3.8 | 1.1 | 0.1 | 5.4 | 3.9 | 1.2 | 0.1 | 5.8 |
| LIA_T | 543 | 541 | 1.0 | 53.7 | 20.2 | 10.5 | 105.5 | 540 | 4.1 | 5.3 | 0.5 | 31.5 | 259.4 | 27.0 | 169.2 | 301.8 | 208.7 | 29.8 | 113.6 | 257.4 |
| HE_BS | 12,820 | 62 | 206.8 | | | | | | 0.0 | 0.0 | 0.0 | 0.1 | 1.5 | 0.9 | 0.3 | 3.7 | 1.7 | 1.1 | 0.2 | 5.4 |
| NJA_T | 4,427 | 4,396 | 1.0 | 16.9 | 6.3 | 0.0 | 39.0 | 4,427 | 10.0 | 9.1 | 0.0 | 37.5 | 279.0 | 32.1 | 0.1 | 338.8 | 218.7 | 33.3 | 0.1 | 294.1 |
| NJDB_T | 1,549 | 11 | 140.8 | 7.7 | 2.1 | 2.8 | 20.0 | 1,434 | 0.2 | 0.2 | 0.0 | 0.8 | 29.1 | 17.6 | 0.0 | 49.2 | 33.2 | 19.2 | 0.0 | 56.8 |
| PSEG_T | 4,881 | 3,704 | 1.3 | 7.3 | 3.5 | 1.1 | 34.1 | 4,876 | 4.0 | 3.8 | 0.0 | 16.2 | 50.0 | 44.5 | 0.1 | 234.1 | 44.3 | 35.9 | 0.1 | 184.3 |
| DEDB_T | 8,059 | 39 | 206.6 | 3.9 | 1.5 | 1.8 | 8.1 | 7,839 | 1.3 | 1.3 | 0.0 | 6.0 | 41.4 | 31.3 | 0.1 | 107.7 | 31.0 | 20.3 | 0.1 | 70.2 |
| VIMS_T | | | | | | | | | | | | | | | | | | | | |
| 1968-1978 | 7,309 | | | 8.1 | 4.7 | 1.0 | 39.0 | 7,308 | 1.5 | 2.0 | 0.0 | 16.1 | 15.0 | 32.2 | 0.0 | 268.0 | 12.1 | 25.0 | 0.0 | 219.7 |
| 1979-2011 | 28,533 | | | 9.1 | 4.6 | 0.0 | 60.9 | 28,530 | 2.7 | 3.1 | 0.0 | 16.4 | 29.3 | 45.3 | 0.0 | 268.3 | 24.0 | 36.0 | 0.0 | 218.6 |
| 1968-2011 | 35,842 | 27,010 | 1.3 | 8.9 | 4.6 | 0.0 | 60.9 | 35,838 | 2.5 | 2.9 | 0.0 | 16.4 | 26.4 | 43.3 | 0.0 | 268.3 | 21.5 | 34.4 | 0.0 | 219.7 |
| NCJUV_T | 24,001 | 775 | 31.0 | 1.4 | 0.9 | 0.1 | 18.0 | 8,049 | 0.2 | 0.5 | 0.0 | 9.2 | 3.7 | 6.5 | 0.0 | 73.7 | 3.4 | 6.4 | 0.0 | 86.0 |
| NCAD_T | 3,200 | 2,037 | 1.6 | 4.5 | 1.2 | 1.8 | 8.5 | 3,195 | 6.1 | 4.4 | 0.0 | 19.7 | 26.2 | 12.6 | 0.0 | 68.5 | 27.6 | 14.7 | 0.0 | 101.8 |
| SEAMAP_T | 6,754 | 4,261 | 1.6 | 8.7 | 2.2 | 0.0 | 19.0 | 6,754 | 5.5 | 5.2 | 0.0 | 40.8 | 265.6 | 30.7 | 119.8 | 419.1 | 247.2 | 33.1 | 165.3 | 443.9 |
| GA_T | 4,210 | 3,563 | 1.2 | 23.5 | 7.7 | 2.0 | 212.0 | 4,189 | 1.4 | 2.2 | 0.0 | 16.3 | 85.6 | 108.2 | 0.0 | 263.1 | 78.9 | 100.4 | 0.0 | 247.4 |
| All surveys | 248,769 | 158,917 | 1.6 | 91.9 | 158.4 | 0.0 | 1,605.0 | 195,576 | 53.0 | 98.3 | 0.0 | 676.2 | 201.2 | 215.8 | 0.0 | 650.0 | 186.1 | 207.2 | 0.0 | 650.0 |

[a] Number of unique locations within a survey, based on coordinates rounded to 0.0001°.

Table 8. Number of sets, number of sets with eels, number of eels, and mean eels per set, by survey and by exposure category.

| Survey | Exposure category | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tidal Fresh | | | | | Sheltered | | | | | Semi-exposed | | | | | Exposed Bay | | | | |
| | Sets | Sets with eels | % of sets with eels | No. eels | Mean eels/ set | Sets | Sets with eels | % of sets with eels | No. eels | Mean eels/ set | Sets | Sets with eels | % of sets with eels | No. eels | Mean eels/ set | Sets | Sets with eels | % of sets with eels | No. eels | Mean eels/ set |
| NL_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 46 | 0 | 0.0 | 0 | 0.000 | 776 | 0 | 0.0 | 0 | 0.000 |
| NGSL_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 1 | 0 | 0.0 | 0 | 0.000 | 6,147 | 0 | 0.0 | 0 | 0.000 |
| SLE_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 187 | 10 | 5.3 | 10 | 0.053 | 0 | 0 | NA | 0 | |
| SGSL_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 1 | 0 | 0.0 | 0 | 0.000 | 5,818 | 1 | 0.0 | 1 | 0.000 |
| SGSL_BS | 0 | 0 | NA | 0 | | 5,810 | 159 | 2.7 | 256 | 0.044 | 410 | 7 | 1.7 | 266 | 0.649 | 203 | 2 | 1.0 | 2 | 0.010 |
| NS_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 70 | 0 | 0.0 | 0 | 0.000 | 2,503 | 0 | 0.0 | 0 | 0.000 |
| SS_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 33 | 0 | 0.0 | 0 | 0.000 | 704 | 1 | 0.1 | 1 | 0.001 |
| NEF_T | 0 | 0 | NA | 0 | | 9 | 0 | 0.0 | 0 | 0.000 | 6 | 1 | 16.7 | 1 | 0.167 | 1,848 | 2 | 0.1 | 2 | 0.001 |
| MENH_T | 0 | 0 | NA | 0 | | 61 | 0 | 0.0 | 0 | 0.000 | 416 | 4 | 1.0 | 4 | 0.010 | 101 | 0 | 0.0 | 0 | 0.000 |
| MA_T | 0 | 0 | NA | 0 | | 1 | 0 | 0.0 | 0 | 0.000 | 1,196 | 7 | 0.6 | 12 | 0.010 | 3,825 | 6 | 0.2 | 6 | 0.002 |
| NEAMAP_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 11 | 0 | 0.0 | 0 | 0.000 | 432 | 6 | 1.4 | 22 | 0.051 |
| RI_T | 0 | 0 | NA | 0 | | 2,651 | 10 | 0.4 | 12 | 0.005 | 2,623 | 4 | 0.2 | 4 | 0.002 | 0 | 0 | NA | 0 | |
| LIS_T | 0 | 0 | NA | 0 | | 18 | 0 | 0.0 | 0 | 0.000 | 5,948 | 9 | 0.2 | 10 | 0.002 | 0 | 0 | NA | 0 | |
| LI_BS | 0 | 0 | NA | 0 | | 4,207 | 161 | 3.8 | 498 | 0.118 | 27 | 1 | 3.7 | 1 | 0.037 | 0 | 0 | NA | 0 | |
| PB_T | 0 | 0 | NA | 0 | | 7,811 | 20 | 0.3 | 22 | 0.003 | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | |
| LIA_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 2 | 0 | 0.0 | 0 | 0.000 | 200 | 3 | 1.5 | 5 | 0.025 |
| HE_BS | 3,736 | 708 | 19.0 | 1,340 | 0.359 | 9,084 | 1,477 | 16.3 | 2,818 | 0.310 | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | |
| NJA_T | 0 | 0 | NA | 0 | | 4 | 0 | 0.0 | 0 | 0.000 | 15 | 0 | 0.0 | 0 | 0.000 | 1,170 | 8 | 0.7 | 11 | 0.009 |
| NJDB_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 555 | 15 | 2.7 | 16 | 0.029 | 994 | 18 | 1.8 | 23 | 0.023 |
| PSEG_T | 565 | 141 | 25.0 | 415 | 0.735 | 527 | 243 | 46.1 | 1,002 | 1.901 | 1,124 | 277 | 24.6 | 1,069 | 0.951 | 2,665 | 9 | 0.3 | 13 | 0.005 |
| DEDB_T | 0 | 0 | NA | 0 | | 862 | 27 | 3.1 | 31 | 0.036 | 4,148 | 1,401 | 33.8 | 6,254 | 1.508 | 3,049 | 80 | 2.6 | 100 | 0.033 |
| VIMS_T[a] | | | | | | | | | | | | | | | | | | | | |
| 1968-1978 | 720 | 142 | 19.7 | | | 3,339 | 736 | 22.0 | | | 2,284 | 344 | 15.1 | | | 962 | 6 | 0.6 | | |
| 1979-2011 | 1,262 | 483 | 38.3 | | | 8,546 | 1,877 | 22.0 | | | 8,986 | 979 | 10.9 | | | 9,739 | 39 | 0.4 | | |
| 1968-2011 | 1,982 | 625 | 31.5 | | | 11,885 | 2,613 | 22.0 | | | 11,270 | 1,323 | 11.7 | | | 10,701 | 45 | 0.4 | | |
| NCJUV_T | 0 | 0 | NA | 0 | | 19,046 | 1,052 | 5.5 | 1,244 | 0.065 | 4,955 | 170 | 3.4 | 225 | 0.045 | 0 | 0 | NA | 0 | |
| NCAD_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 3,200 | 14 | 0.4 | 14 | 0.004 | 0 | 0 | NA | 0 | |
| SEAMAP_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | |
| GA_T | 0 | 0 | NA | 0 | | 2,148 | 3 | 0.1 | 3 | 0.001 | 857 | 0 | 0.0 | 0 | 0.000 | 0 | 0 | NA | 0 | |
| All surveys[b] | 6,283 | 1,474 | 23.5 | 1,755 | 0.279 | 64,124 | 5,765 | 9.0 | 5,886 | 0.092 | 37,101 | 3,243 | 8.7 | 7,886 | 0.213 | 41,136 | 181 | 0.4 | 186 | 0.005 |

Table 8 (continued)

| Survey | Exposure category | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Exposed Ocean | | | | | Deep Ocean | | | | | All categories | | | | |
| | Sets | Sets with eels | % of sets with eels | No. eels | Mean eels/ set | Sets | Set with eels | % of sets with eels | No. eels | Mean eels/ set | Sets | Sets with eels | % of sets with eels | No. eels | Mean eels/ set |
| NL_T | 35,288 | 0 | 0.0 | 0 | 0.000 | 5,526 | 0 | 0.0 | 0 | 0.000 | 41,636 | 0 | 0.0 | 0 | 0.000 |
| NGSL_T | 465 | 0 | 0.0 | 0 | 0.000 | 0 | 0 | NA | 0 | | 6,613 | 0 | 0.0 | 0 | 0.000 |
| SLE_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 187 | 10 | 5.3 | 10 | 0.051 |
| SGSL_T | 61 | 0 | 0.0 | 0 | 0.000 | 0 | 0 | NA | 0 | | 5,880 | 1 | 0.0 | 1 | 0.000 |
| SGSL_BS | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 6,423 | 168 | 2.6 | 524 | 0.080 |
| NS_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 2,573 | 0 | 0.0 | 0 | 0.000 |
| SS_T | 12,839 | 4 | 0.0 | 8 | 0.001 | 216 | 0 | 0.0 | 0 | 0.000 | 13,792 | 5 | 0.0 | 9 | 0.001 |
| NEF_T | 30,217 | 21 | 0.1 | 52 | 0.002 | 79 | 0 | 0.0 | 0 | 0.000 | 32,159 | 24 | 0.1 | 55 | 0.002 |
| MENH_T | 1,490 | 1 | 0.1 | 1 | 0.001 | 0 | 0 | NA | 0 | | 2,068 | 5 | 0.2 | 5 | 0.002 |
| MA_T | 1,326 | 0 | 0.0 | 0 | 0.000 | 0 | 0 | NA | 0 | | 6,348 | 13 | 0.2 | 18 | 0.003 |
| NEAMAP_T | 1,076 | 3 | 0.3 | 3 | 0.003 | 0 | 0 | NA | 0 | | 1,519 | 9 | 0.6 | 25 | 0.016 |
| RI_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 5,274 | 14 | 0.3 | 16 | 0.003 |
| LIS_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 5,966 | 9 | 0.2 | 10 | 0.002 |
| LI_BS | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 4,234 | 162 | 3.8 | 499 | 0.114 |
| PB_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 7,811 | 20 | 0.3 | 22 | 0.003 |
| LIA_T | 341 | 4 | 1.2 | 4 | 0.012 | 0 | 0 | NA | 0 | | 543 | 7 | 1.3 | 9 | 0.016 |
| HE_BS | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 12,820 | 2,185 | 17.0 | 4,158 | 0.277 |
| NJA_T | 3,238 | 19 | 0.6 | 28 | 0.009 | 0 | 0 | NA | 0 | | 4,427 | 27 | 0.6 | 39 | 0.009 |
| NJDB_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 1,549 | 33 | 2.1 | 39 | 0.025 |
| PSEG_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 4,881 | 670 | 13.7 | 2,499 | 0.512 |
| DEDB_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 8,059 | 1,508 | 18.7 | 6,385 | 0.667 |
| VIMS_T[a] | | | | | | | | | | | | | | | |
| 1968-1978 | 4 | 0 | 0.0 | | | 0 | 0 | NA | | | 7,309 | 1,228 | 16.8 | | |
| 1979-2011 | 0 | 0 | NA | | | 0 | 0 | NA | | | 28,533 | 3,378 | 11.8 | | |
| 1968-2011 | 4 | 0 | 0.0 | | | 0 | 0 | NA | | | 35,842 | 4,606 | 12.9 | | |
| NCJUV_T | 0 | 0 | NA | 0 | 0.000 | 0 | 0 | NA | 0 | | 24,001 | 1,222 | 5.1 | 1,469 | 0.058 |
| NCAD_T | 0 | 0 | NA | 0 | | 0 | 0 | NA | 0 | | 3,200 | 14 | 0.4 | 14 | 0.004 |
| SEAMAP_T | 6,754 | 0 | 0.0 | 0 | 0.000 | 0 | 0 | NA | 0 | | 6,754 | 0 | 0.0 | 0 | 0.000 |
| GA_T | 1,205 | 0 | 0.0 | 0 | 0.000 | 0 | 0 | NA | 0 | | 4,210 | 3 | 0.1 | 3 | 0.001 |
| All surveys[b] | 94,304 | 52 | 0.1 | 96 | 0.001 | 5,821 | 0 | 0.0 | 0 | 0.000 | 248,769 | 10,715 | 4.3 | 15,809 | 0.061 |

[a] Values for Number of eels and Mean eels/set are unavailable for VIMS_T

[b] Values for Number of eels and Mean eels/set exclude VIMS_T

Table 9. Weights of American eels sampled during surveys.

| Survey | Date | Time | Long | Lat | Depth (m) | Length (cm) | Weight (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Reported | Calculated[a] | % residual[b] |
| SGSL_T | 24 Sep 2006 | 05:30 | -60.8633 | 47.9037 | 58.5 | 37.0 | 86 | 83.3 | -3.2 |
| NEF_T | 19 Apr 1970 | 12:54 | -70.1500 | 40.0833 | 165.0 | | 900 | | |
| NEF_T | 1 Oct 1972 | 22:55 | -74.3833 | 37.6333 | 76.0 | | 900 | | |
| NEF_T | 8 Oct 1972 | 04:32 | -71.6500 | 40.5667 | 72.0 | | 500 | | |
| NEF_T | 30 Oct 1972 | 01:17 | -77.5500 | 33.9333 | 24.0 | | 900 | | |
| NEF_T | 3 Nov 1972 | 08:50 | -80.3333 | 31.4000 | 37.0 | | 500 | | |
| NEF_T | 5 Nov 1972 | 14:17 | -73.8167 | 40.5667 | 10.0 | | 900 | | |
| NEF_T | 12 Nov 1972 | 01:19 | -75.0667 | 38.0667 | 19.0 | | 500 | | |
| NEF_T | 20 Sep 1986 | 20:26 | -75.1667 | 38.0000 | 19.0 | | 200 | | |
| NEF_T | 20 Sep 1995 | 00:16 | -72.4833 | 39.7000 | 87.0 | | 300 | | |
| NEF_T | 9 Mar 1997 | 20:56 | -76.0167 | 37.0000 | 16.0 | | 300 | | |
| NEF_T | 3 Mar 1999 | 01:37 | -73.1588 | 38.9293 | 79.0 | | 200 | | |
| NEF_T | 31 Mar 1999 | 04:07 | -70.0182 | 40.2308 | 92.0 | | 300 | | |
| NEF_T | 24 Mar 2000 | 18:31 | -75.1357 | 38.2103 | 10.0 | | 100 | | |
| NEF_T | 14 Mar 2001 | 13:32 | -75.4385 | 37.4403 | 21.0 | | 1 | | |
| MENH_T | 11 Oct 2001 | 12:56 | -68.7532 | 44.1380 | 28.3 | | 190 | | |
| MENH_T | 29 Oct 2002 | 14:35 | -69.0054 | 44.0819 | 51.5 | | 80 | | |
| MENH_T | 27 Oct 2005 | 12:35 | -69.0702 | 43.5457 | 70.9 | | 750 | | |
| MENH_T | 18 Oct 2006 | 14:51 | -68.9308 | 44.1752 | 33.4 | | 80 | | |
| MENH_T | 14 Oct 2008 | 15:41 | -68.9653 | 44.1373 | 34.9 | | 100 | | |
| MA_T | 16 May 1985 | 14:12 | -70.8190 | 41.6072 | 8.0 | | 300 | | |
| MA_T | 11 Sep 1985 | 07:36 | -70.7158 | 41.6375 | 8.0 | | 100 | | |
| MA_T | 15 May 1986 | 11:46 | -70.4517 | 41.4362 | 15.0 | | 300 | | |
| MA_T | 21 May 1991 | 09:41 | -70.9133 | 41.5853 | 6.0 | | 600 | | |
| MA_T | 19 Sep 1995 | 08:52 | -70.5492 | 41.3172 | 16.0 | | 200 | | |
| MA_T | 21 Sep 1995 | 08:58 | -70.7725 | 41.5802 | 14.0 | | 200 | | |
| NEAMAP_T | 20 Oct 2009 | 12:10 | -75.0792 | 38.2457 | 48.0 | 31.5 | 65 | 57.2 | -12.0 |
| NEAMAP_T | 14 Oct 2010 | 11:59 | -74.8775 | 38.6797 | 90.0 | 32.1 | 162 | 60.8 | -62.5 |
| NEAMAP_T | 1 Oct 2011 | 09:40 | -71.7025 | 41.2094 | 111.0 | 41.5 | 130 | 137.5 | 5.8 |
| NEAMAP_T | 1 Oct 2011 | 11:22 | -71.7695 | 41.1832 | 96.0 | 42.5 | 168 | 148.3 | -11.7 |
| NEAMAP_T | 1 Oct 2011 | 12:26 | -71.7966 | 41.1985 | 127.0 | 46.0 | 40 | 190.8 | 376.9 |
| NEAMAP_T | 15 Oct 2011 | 14:47 | -75.3158 | 37.8276 | 43.0 | 47.5 | 92 | 211.3 | 129.6 |
| LIA_T | 5 Jan 2006 | 15:28 | -73.6213 | 40.3690 | 85.0 | | 80 | | |
| LIA_T | 6 Jan 2006 | 09:25 | -73.5222 | 40.5503 | 59.5 | | 750 | | |
| LIA_T | 7 Jan 2006 | 07:02 | -72.8932 | 40.7117 | 42.0 | | 50 | | |
| LIA_T | 6 Jun 2006 | 11:08 | -72.0420 | 40.9865 | 39.0 | | 10 | | |
| LIA_T | 20 Nov 2006 | 07:23 | -71.7983 | 41.0367 | 61.5 | | 120 | | |
| NJA_T | 9 Nov 1988 | 11:01 | -74.0667 | 39.9667 | 9.0 | | 500 | | |
| NJA_T | 24 Oct 1989 | 14:43 | -74.7935 | 38.9722 | 9.0 | | 100 | | |
| NJA_T | 4 Dec 1989 | 11:35 | -73.9597 | 40.4638 | 6.0 | | 1,000 | | |
| NJA_T | 11 Dec 1989 | 11:35 | -74.0325 | 40.0792 | 9.0 | | 200 | | |
| NJA_T | 11 Dec 1989 | 13:23 | -74.0470 | 39.9533 | 16.0 | | 360 | | |
| NJA_T | 2 Nov 1991 | 10:43 | -74.2213 | 39.5557 | 11.0 | | 100 | | |
| NJA_T | 4 Nov 1991 | 15:12 | -75.0238 | 38.8663 | 14.0 | | 40 | | |
| NJA_T | 19 Jan 1995 | 11:11 | -74.0188 | 40.1403 | 10.0 | | 600 | | |
| NJA_T | 21 Oct 1996 | 08:23 | -73.9758 | 40.4475 | 6.0 | | 20 | | |
| NJA_T | 11 Feb 1998 | 10:51 | -74.7548 | 39.0368 | 9.0 | | 20 | | |
| NJA_T | 20 Jan 2000 | 17:01 | -74.7940 | 38.9733 | 9.0 | | 900 | | |
| NJA_T | 29 Oct 2003 | 09:07 | -74.4842 | 39.3170 | 10.0 | | 100 | | |
| NJA_T | 30 Oct 2004 | 13:51 | -74.6857 | 39.1150 | 9.0 | | 100 | | |
| NJA_T | 31 Oct 2004 | 07:20 | -74.3858 | 39.3578 | 9.0 | | 100 | | |
| NJA_T | 27 Oct 2005 | 16:58 | -74.0830 | 39.8303 | 11.0 | | 740 | | |
| NJA_T | 29 Oct 2005 | 07:26 | -74.4168 | 39.3453 | 9.0 | | 50 | | |
| NJA_T | 30 Oct 2005 | 09:53 | -74.9178 | 38.8255 | 15.0 | | 50 | | |
| NJA_T | 29 Oct 2006 | 08:07 | -74.7575 | 39.0158 | 11.0 | | 80 | | |
| NJA_T | 17 Jan 2007 | 14:38 | -73.9740 | 40.4463 | 9.0 | | 490 | | |
| NJA_T | 20 Jan 2008 | 08:26 | -74.0660 | 39.9307 | 11.0 | | 490 | | |
| NJA_T | 22 Jan 2008 | 15:10 | -74.6818 | 39.1397 | 8.0 | | 600 | | |
| NJA_T | 20 Oct 2009 | 09:47 | -73.9978 | 40.2117 | 13.0 | | 590 | | |
| NJA_T | 21 Oct 2009 | 15:02 | -74.0667 | 39.9313 | 10.0 | | 40 | | |
| GA_T | 15 Oct 2003 | 10:15 | -81.4322 | 30.9493 | | 22.1 | 10 | 19.2 | 91.5 |
| GA_T | 9 Jan 2007 | 07:25 | -80.9960 | 31.9480 | 30.3 | 47.4 | 232 | 225.4 | -2.8 |
| GA_T | 4 Sep 2009 | 10:52 | -81.4261 | 31.2118 | 24.6 | 25.4 | 232 | 30.0 | -87.1 |

[a] Weight calculated as a x Length$^b$, where length is in mm and weight is in g.
For SGSL_T, a=0.0000001286 and b=3.1970 (Cairns et al. 2014). For NEAMAP_T, a=0.0000006500, b=3.18 (Clark 2009). For GA_T, a=0.00000050847, b=3.2315 (Helfman et al. 1984).

[b] % residual is 100 x (calculated weight-recorded weight)/recorded weight.

Table 10. Mean lengths and weights of American eels sampled during surveys.

| Survey | Length (cm) | | | | | Weight (g) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Min | Max | N | Mean | SD | Min | Max | N |
| SLE_T | 79.4 | 3.7 | 76.8 | 82.0 | 2 | | | | | |
| SGSL_T | 37.0 | NA | 37.0 | 37.0 | 1 | 86.0 | NA | 86.0 | 86.0 | 1 |
| NEF_T | | | | | | 464.4 | 320.0 | 1.0 | 900.0 | 14 |
| MENH_T | | | | | | 240.1 | 288.7 | 80.0 | 750.0 | 5 |
| MA_T | | | | | | 283.3 | 172.2 | 100.0 | 600.0 | 6 |
| NEAMAP_T | 38.7 | 5.6 | 30.5 | 50.0 | 25 | 109.5 | 52.4 | 40.0 | 168.0 | 6 |
| LIA_T | | | | | | 202.0 | 309.0 | 10.0 | 750.0 | 5 |
| NJA_T | | | | | | 316.1 | 308.4 | 20.0 | 1000.0 | 23 |
| PSEG_T | 25.0 | 6.6 | 9.7 | 60.2 | 263 | | | | | |
| DEDB_T | 24.8 | 7.1 | 5.5 | 69.0 | 2,656 | | | | | |
| NCJUV_T | 24.8 | 13.9 | 4.5 | 92.1 | 1,742 | | | | | |
| NCAD_T | 49.0 | 9.4 | 24.0 | 63.2 | 14 | | | | | |
| GA_T | 31.6 | 13.8 | 22.1 | 47.4 | 3 | 158.0 | 128.2 | 10.0 | 232.0 | 3 |

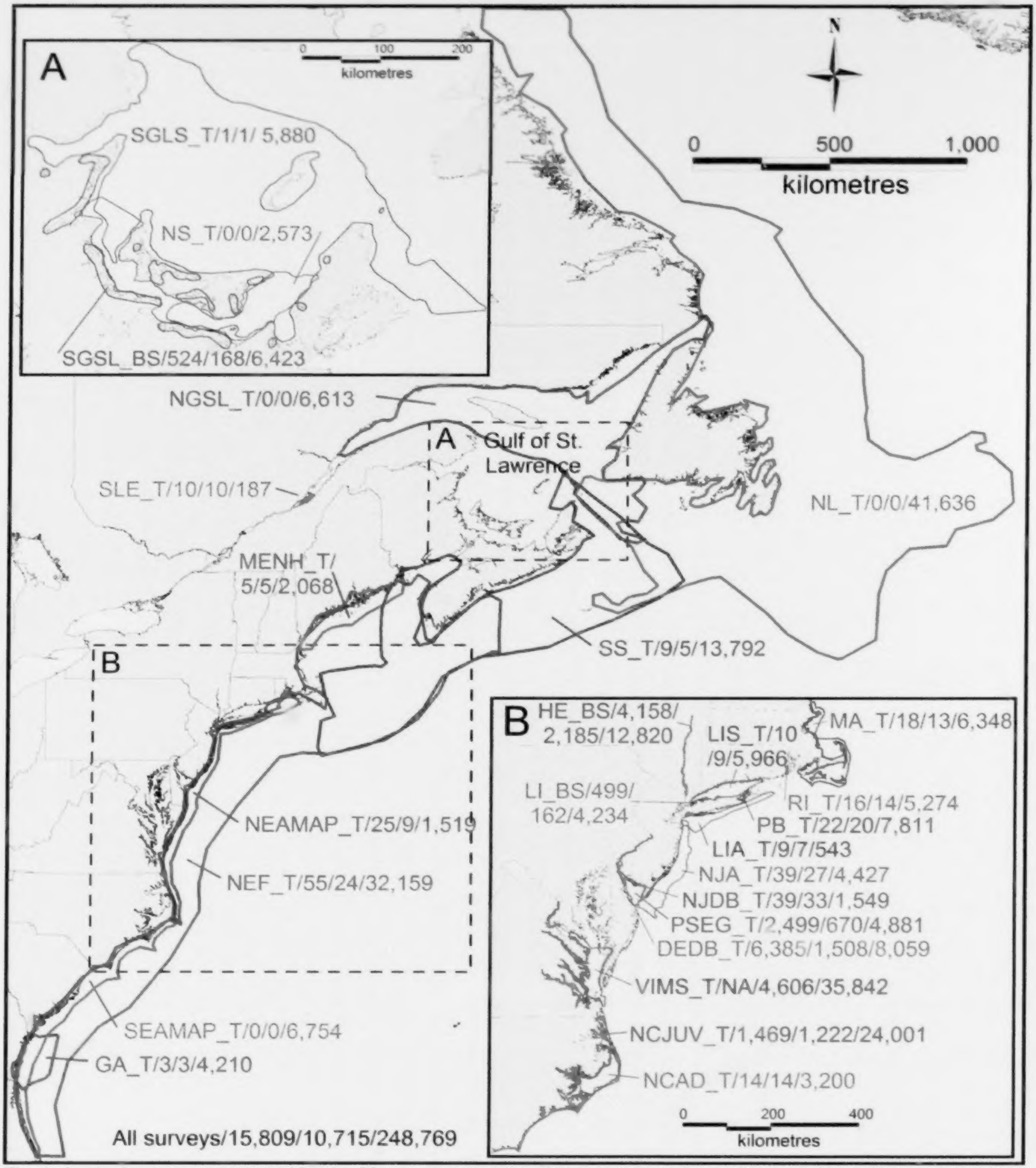


Fig. 1. Approximate areas covered by the 26 surveys treated in this report, as indicated by coloured polygons. Text of the same colour gives survey abbreviations, the number of eels caught, the number of sets which caught eels, and the total number of sets. Inset A shows survey locations in the southern Gulf of St. Lawrence and Inset B shows locations of inshore surveys on the US coast from Massachusetts to North Carolina.

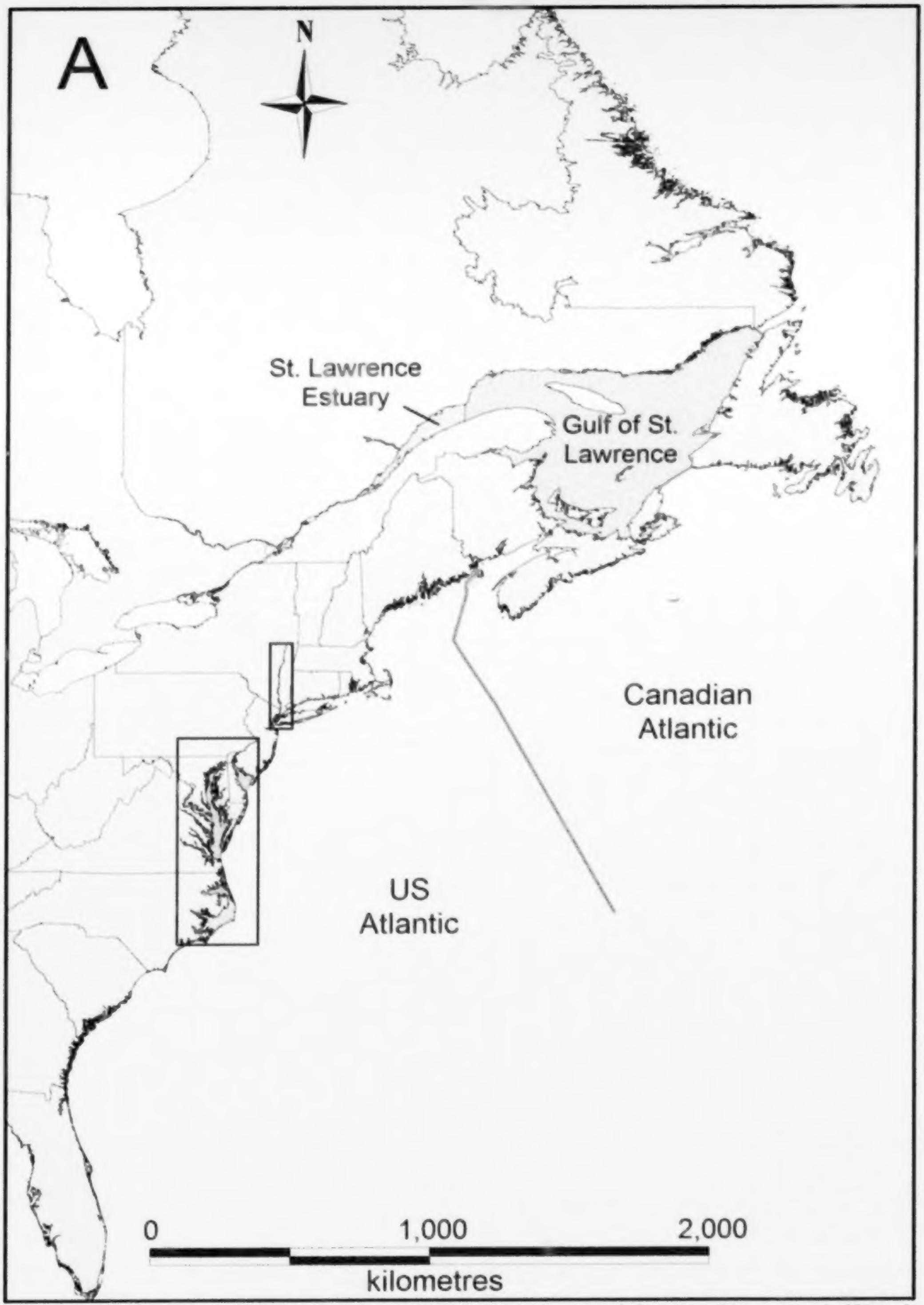


Fig. 2. The east coast of North America, showing Waterbodies defined in this study. A. Waterbodies in Canada and the Atlantic Ocean. Boxes indicate areas that are enlarged in Fig. 2B and Fig. 2C. B. Waterbodies in the Hudson Estuary. C. Waterbodies in the Delaware Bay and Chesapeake Bay regions and in North Carolina sounds.

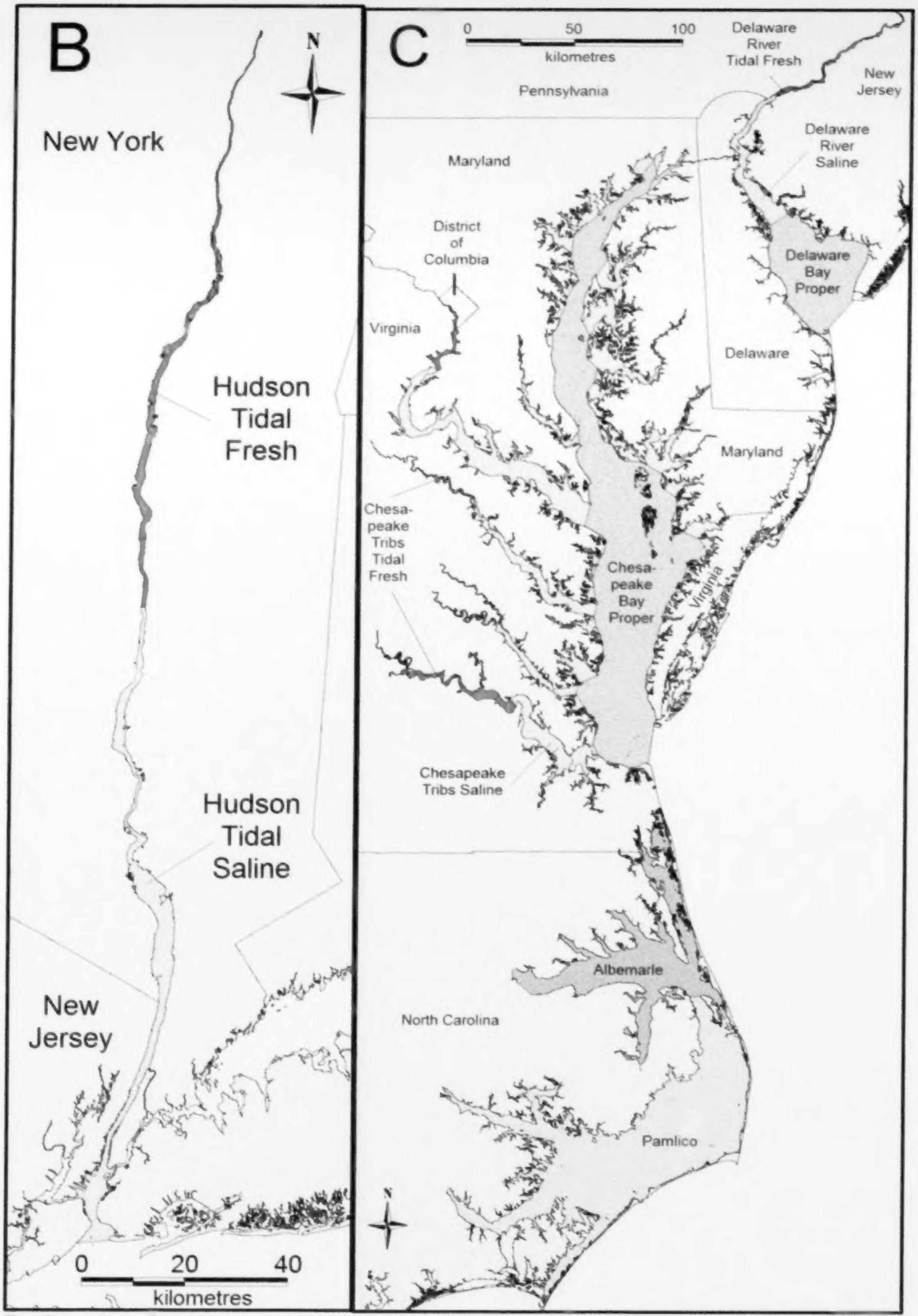


Fig. 2 (continued)

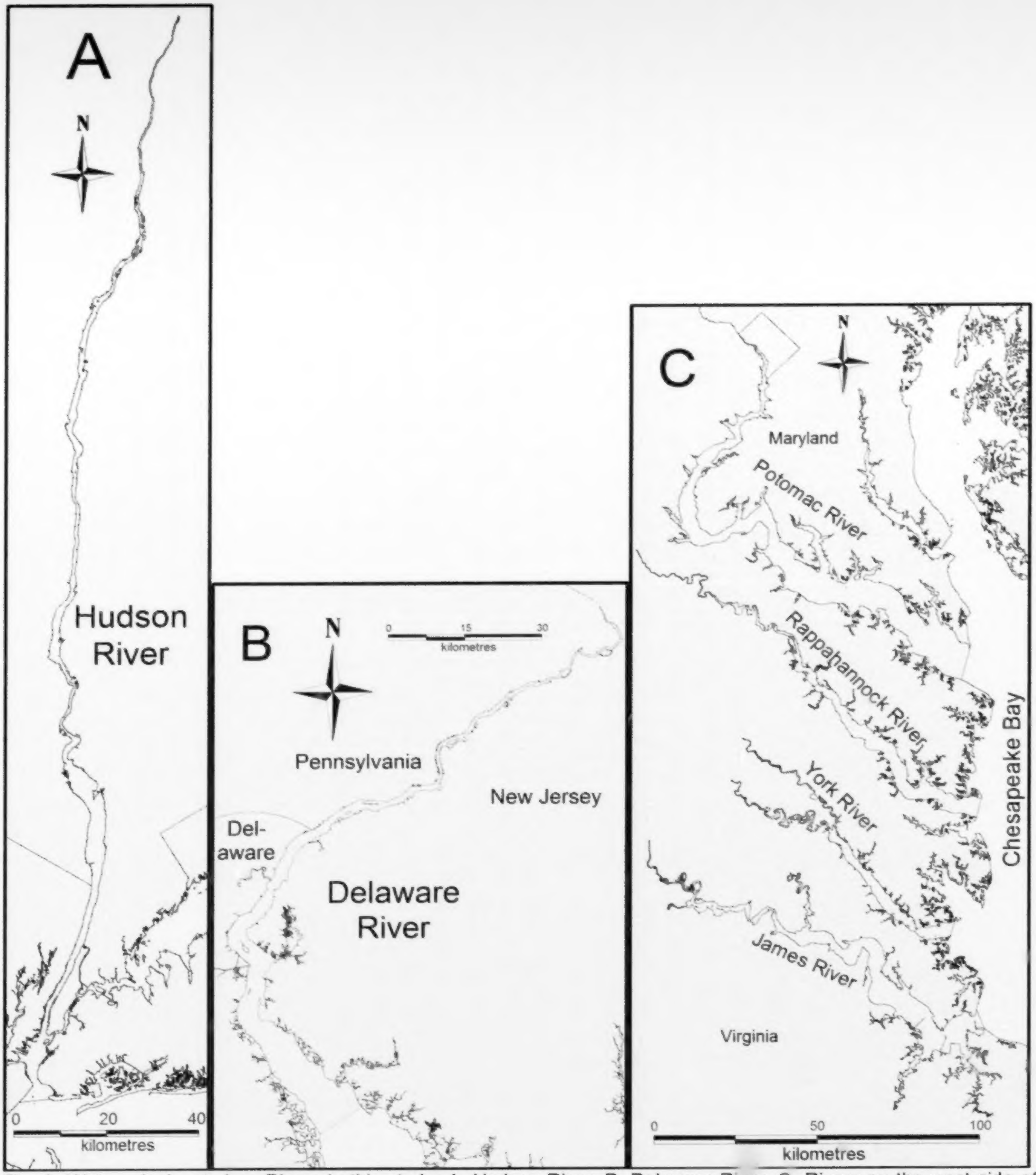


Fig. 3. Waters designated as Rivers in this study. A. Hudson River. B. Delaware River. C. Rivers on the west side of Chesapeake Bay.

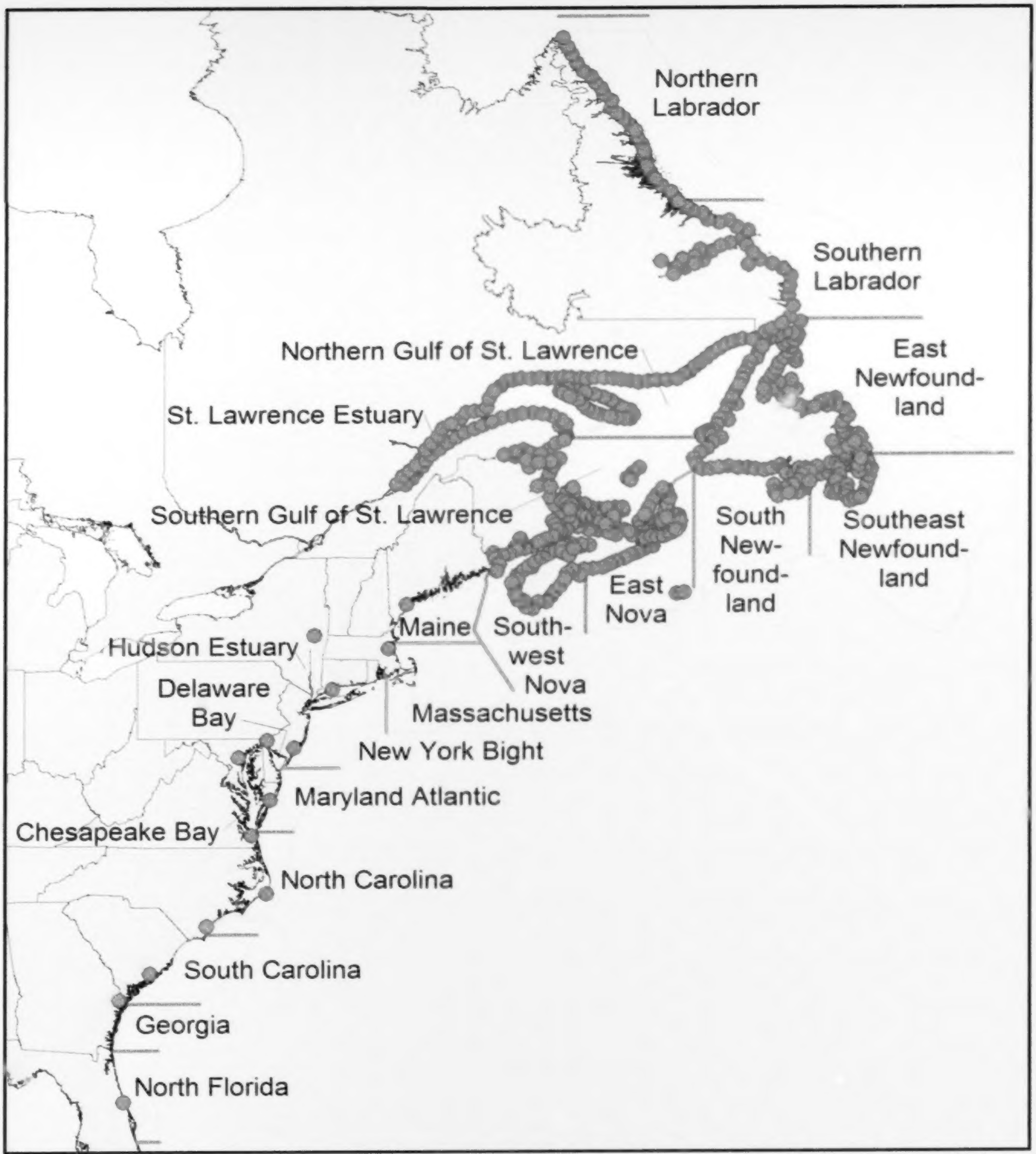
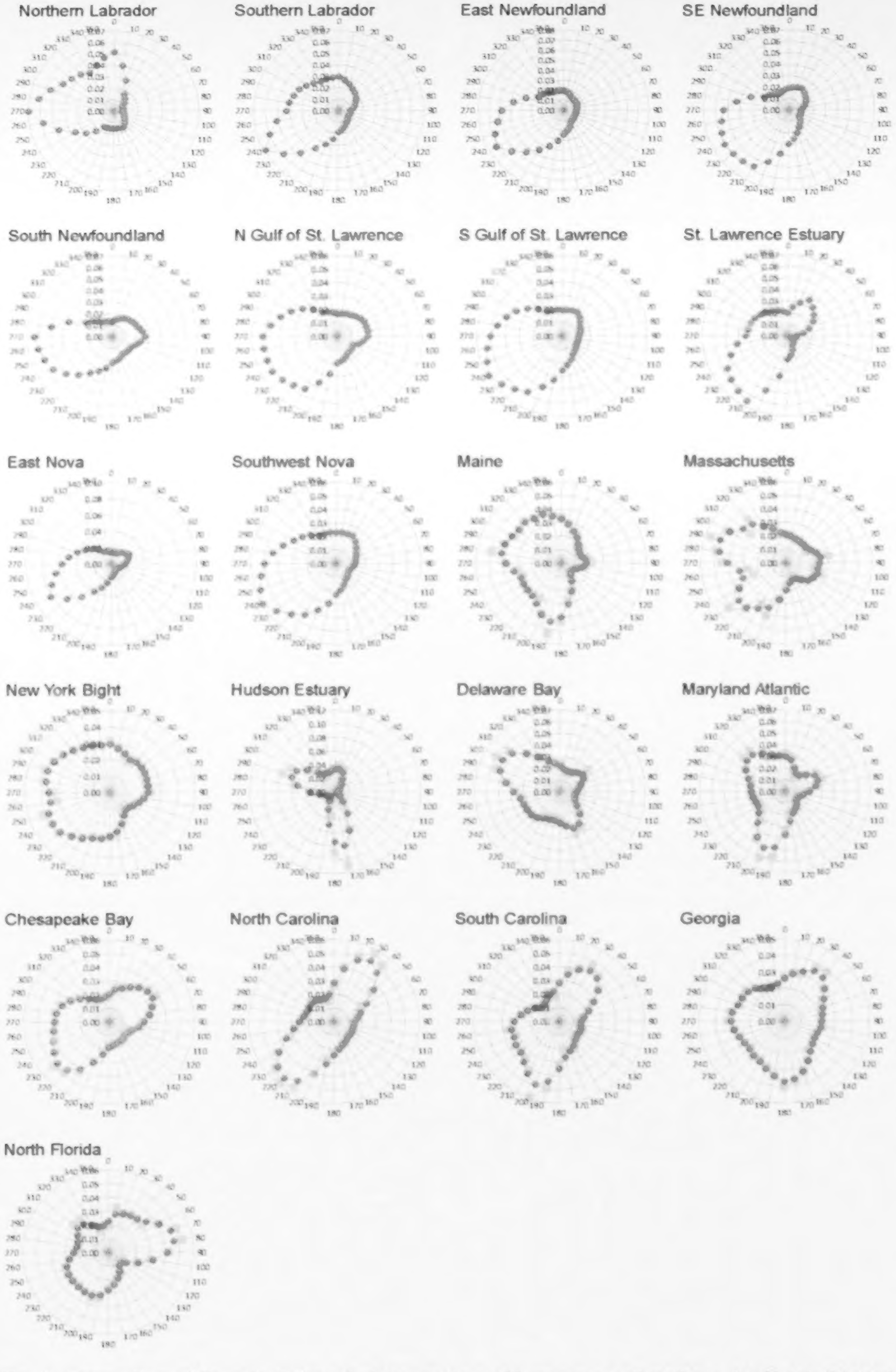


Fig. 4. Eastern North America, showing Fetch Districts. Red dots indicate locations where the frequency distributions of wind directions were modeled (Canadian districts) or calculated (US districts).



Northern Labrador
Southern Labrador
East Newfoundland
SE Newfoundland
South Newfoundland
N Gulf of St. Lawrence
S Gulf of St. Lawrence
St. Lawrence Estuary
East Nova
Southwest Nova
Maine
Massachusetts
New York Bight
Hudson Estuary
Delaware Bay
Maryland Atlantic
Chesapeake Bay
North Carolina
South Carolina
Georgia
North Florida

Fig. 5. Proportion of time that the wind blows from 36 compass directions, by Fetch District. For US Fetch Districts, blue squares indicate raw proportions and red dots indicate smoothed proportions. See text for data sources and calculation methods.

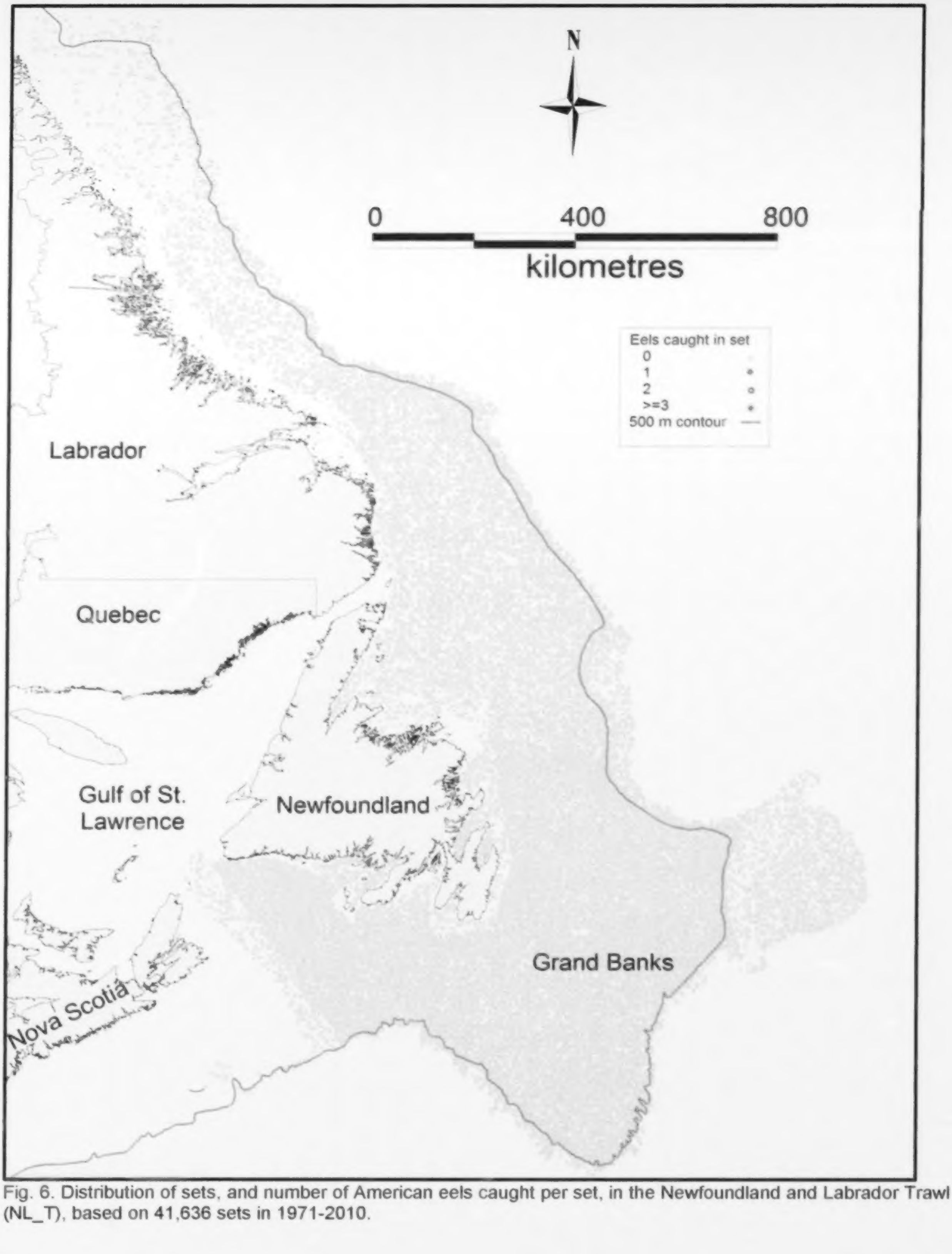


Fig. 6. Distribution of sets, and number of American eels caught per set, in the Newfoundland and Labrador Trawl Survey (NL_T), based on 41,636 sets in 1971-2010.

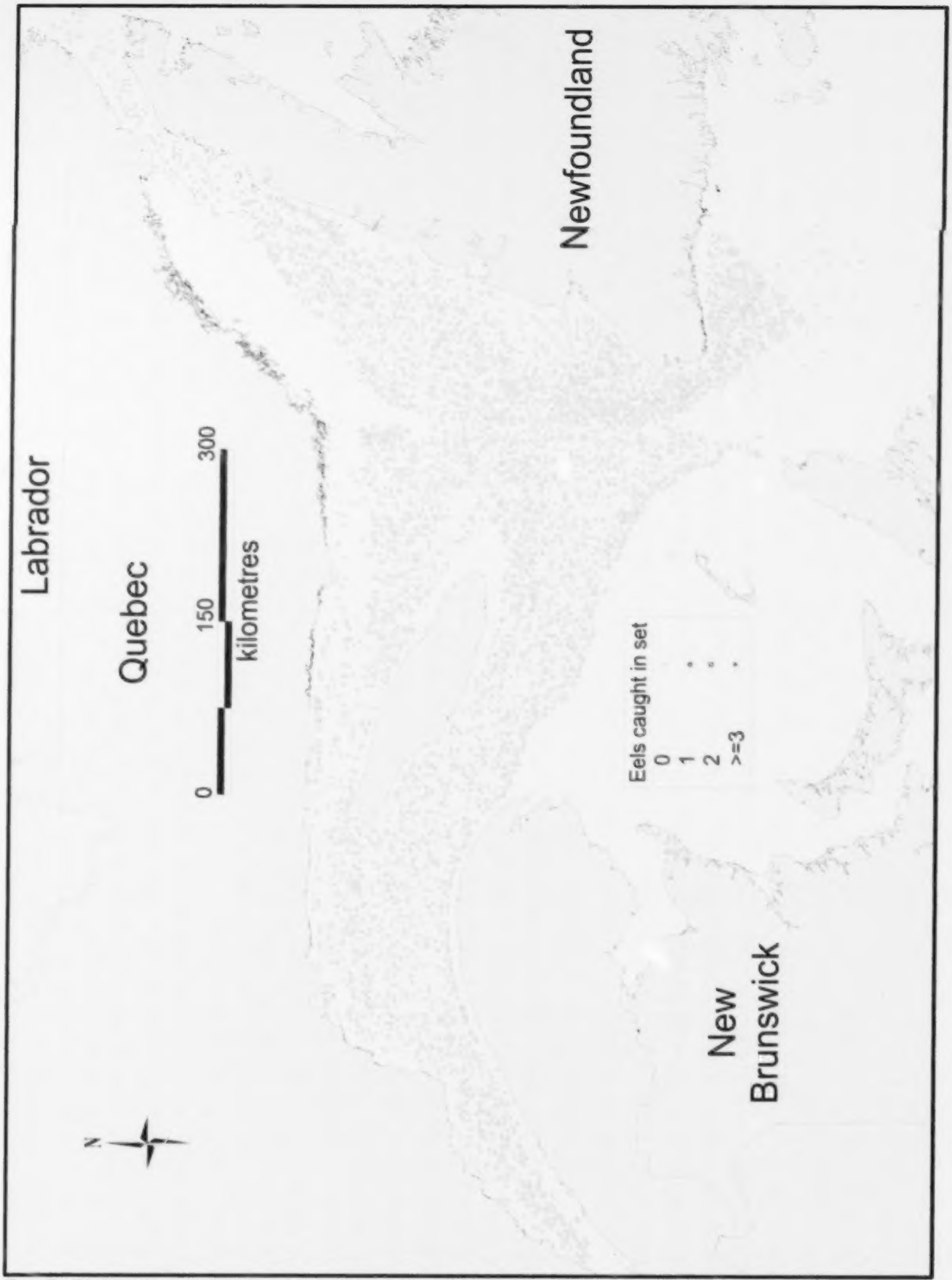


Fig. 7. Distribution of sets, and number of American eels caught per set, in the Northern Gulf of St. Lawrence Trawl Survey (NGSL_T), based on 6,613 sets in 1985-2010.

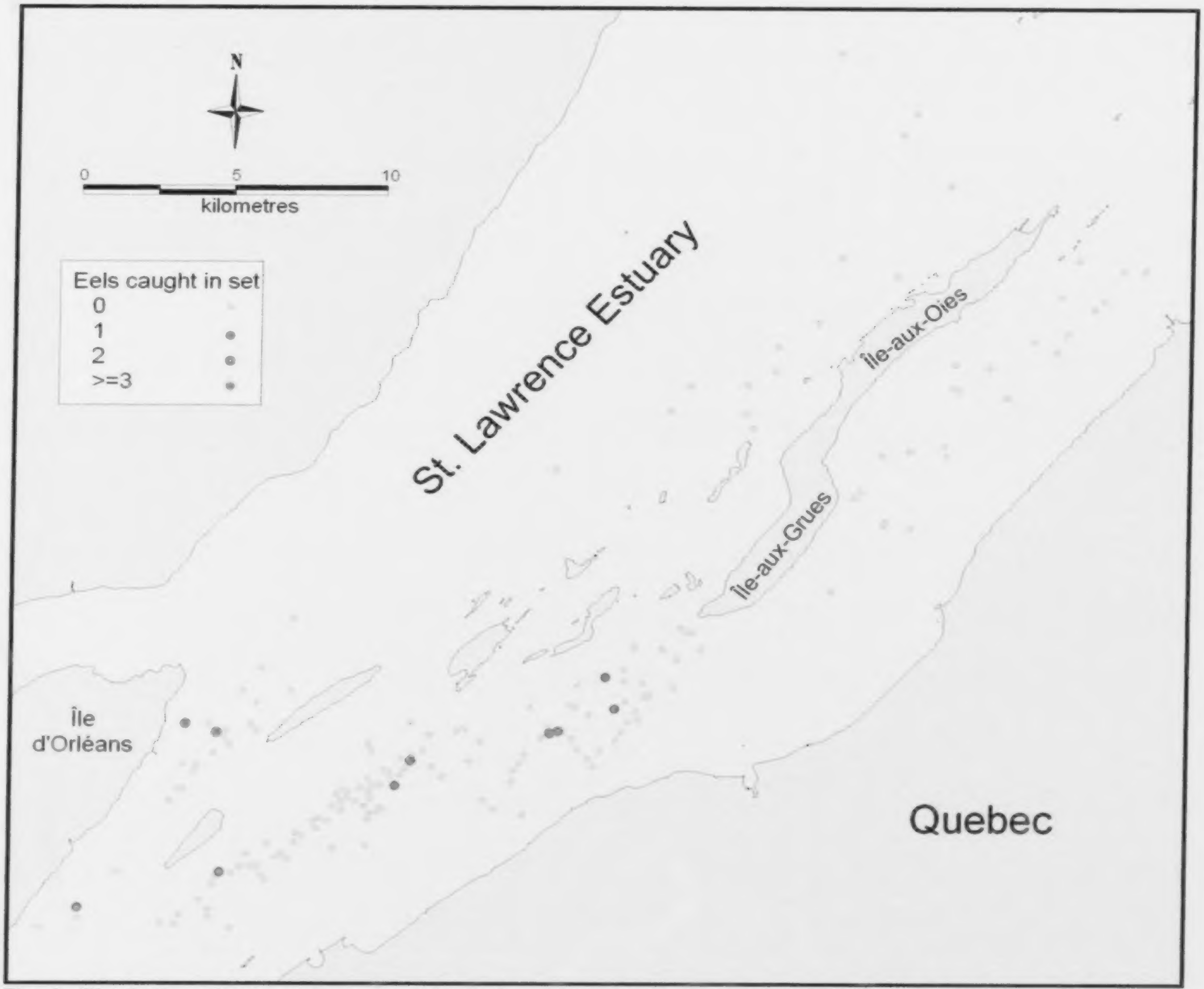


Fig. 8. Distribution of sets, and number of American eels caught per set, in the St. Lawrence Estuary Trawl Survey (SLE_T), based on 187 sets in 2000 and 2001.

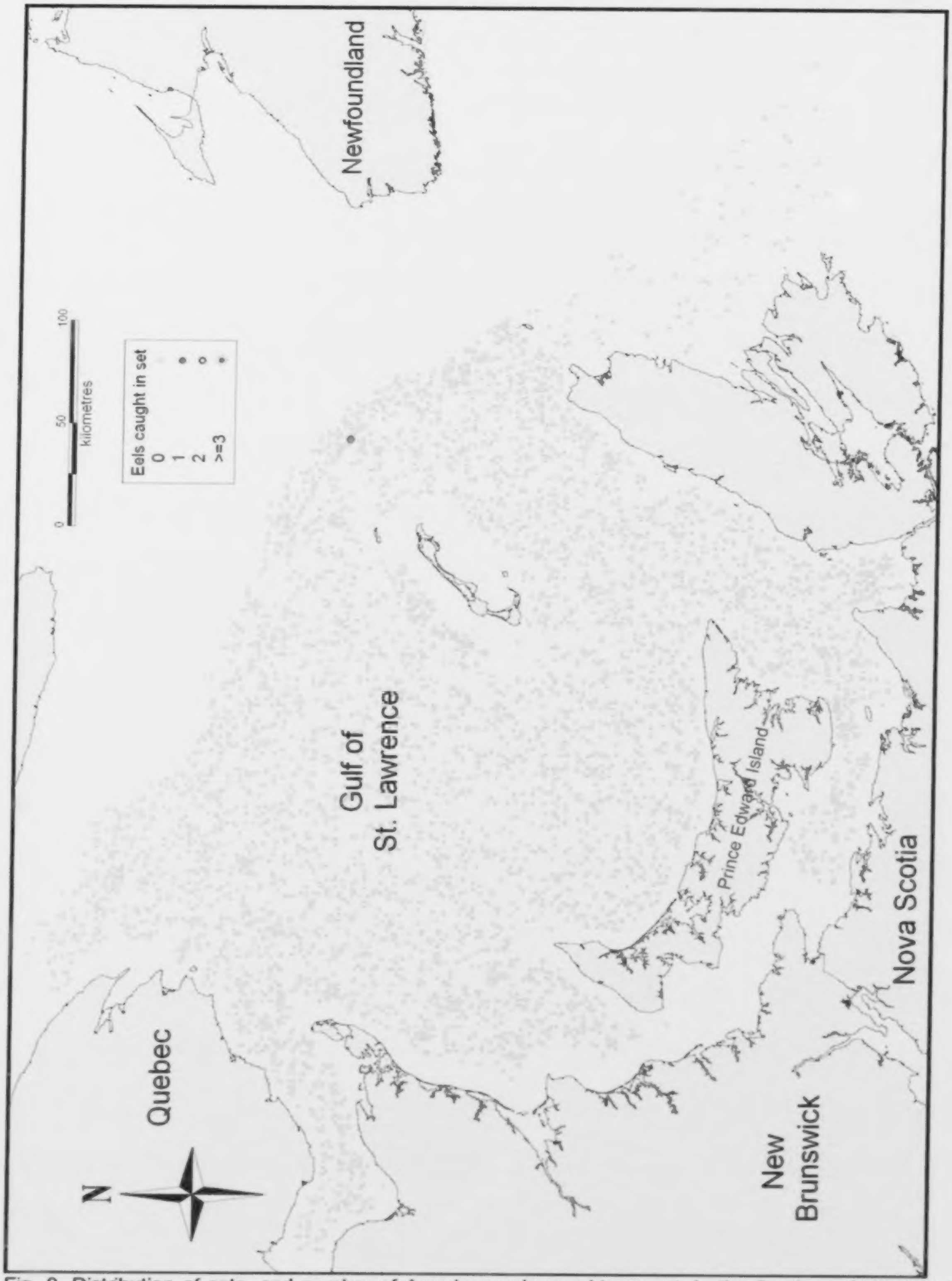


Fig. 9. Distribution of sets, and number of American eels caught per set, in the Southern Gulf of St. Lawrence Trawl Survey (SGSL_T), based on 5,880 sets in 1971-2010.

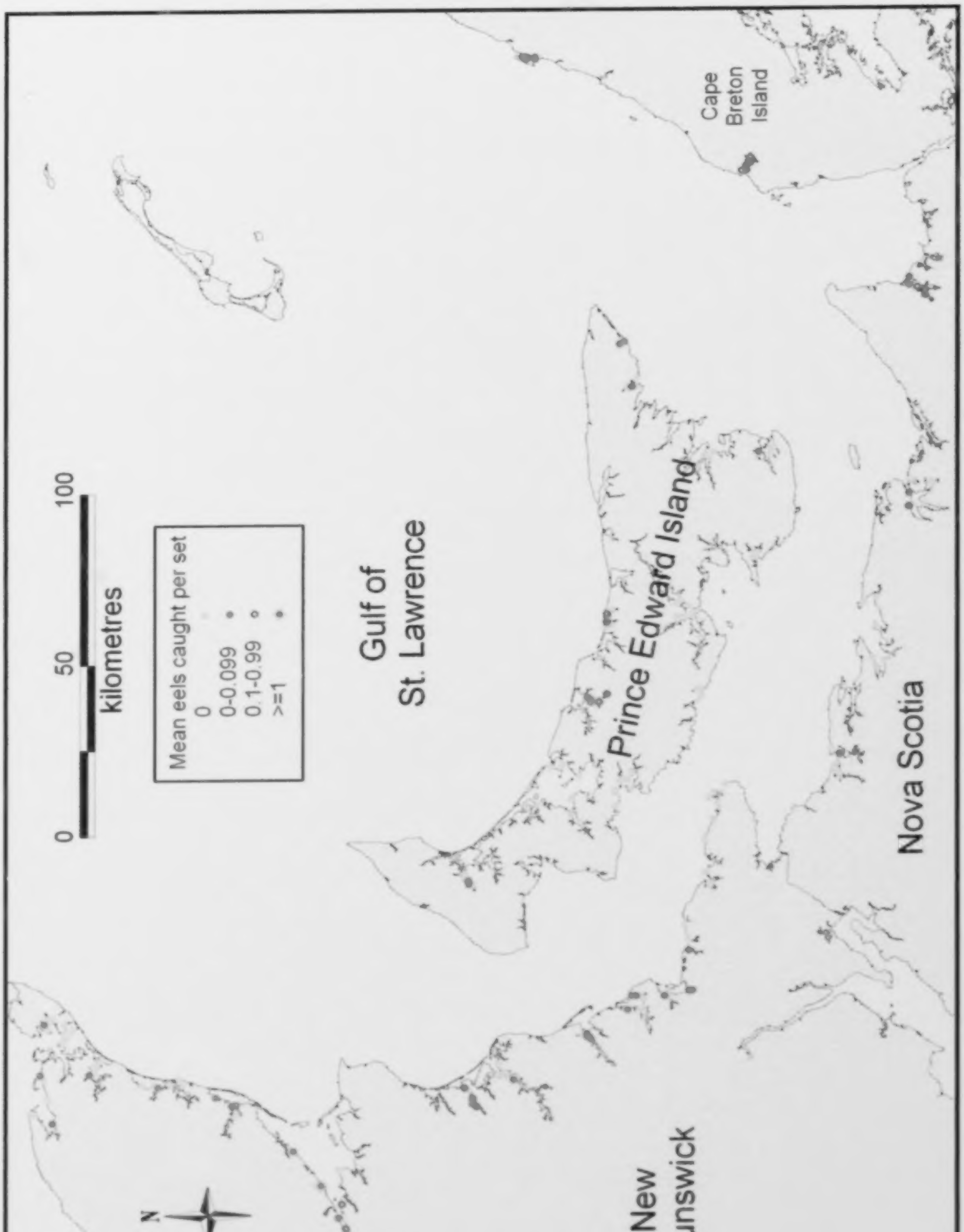


Fig. 10. Distribution of sets, and number of American eels caught per set, in the Southern Gulf of St. Lawrence Beach Seine Survey (SGSL_BS), based on 6,423 sets in 2004-2012. Each symbol represents multiple sets within rectangles measuring 0.01° longitude x 0.01° latitude.

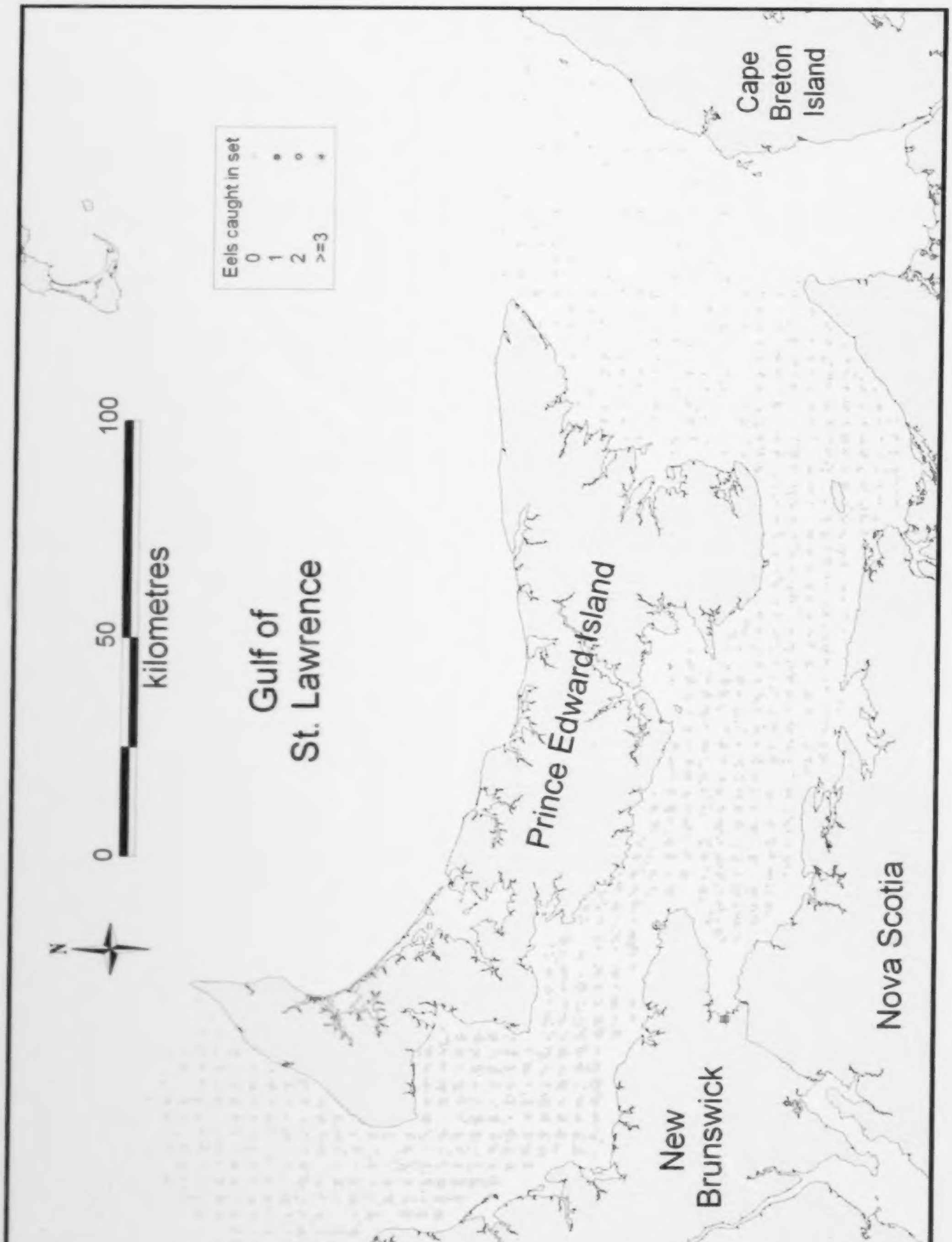


Fig. 11. Distribution of sets, and number of American eels caught per set, in the Northumberland Strait Trawl Survey (NS_T), based on 2,573 sets in 2000-2010.

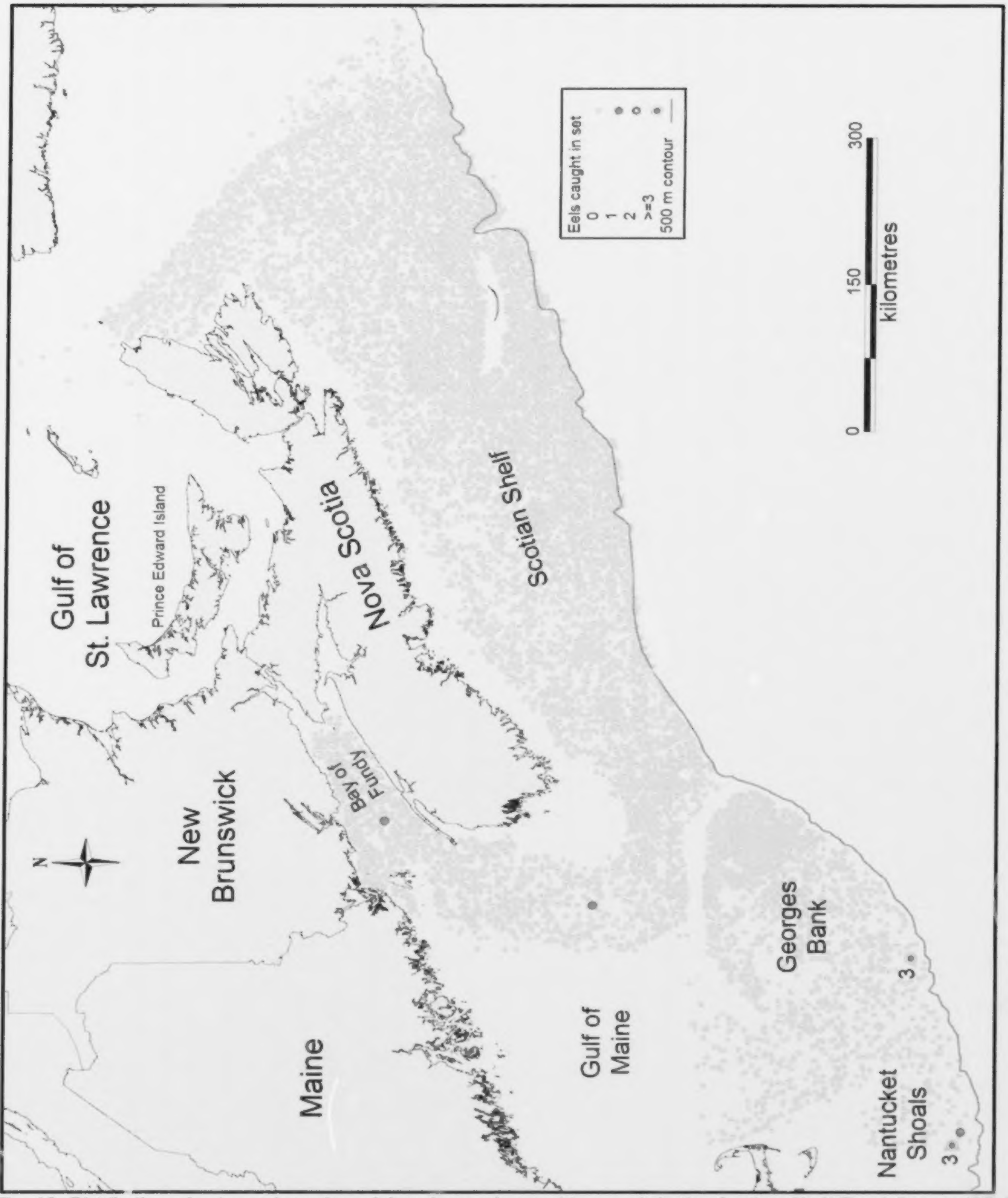


Fig. 12. Distribution of sets, and number of American eels caught per set, in the Scotian Shelf Trawl Survey (SS_T), based on 13,792 sets in 1970-2011. Numbers adjacent to symbols indicate the number of eels captured.

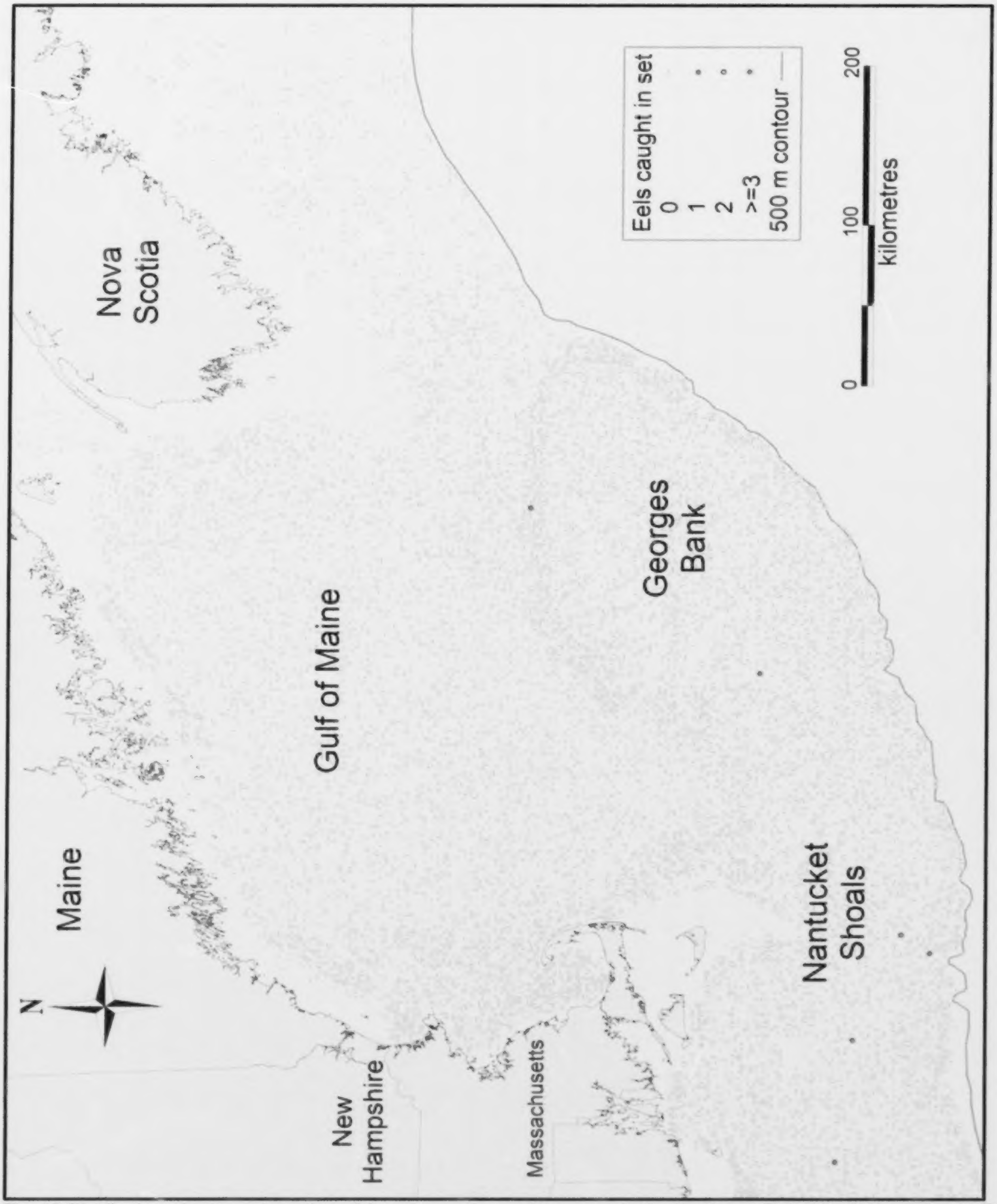


Fig. 13 Distribution of sets, and number of American eels caught per set, in the Northeast Fisheries Science Center Trawl Survey (NEF_T), based on 32,159 sets in 1963-2011. Numbers adjacent to symbols indicate the number of eels captured. Part A, northern sector.

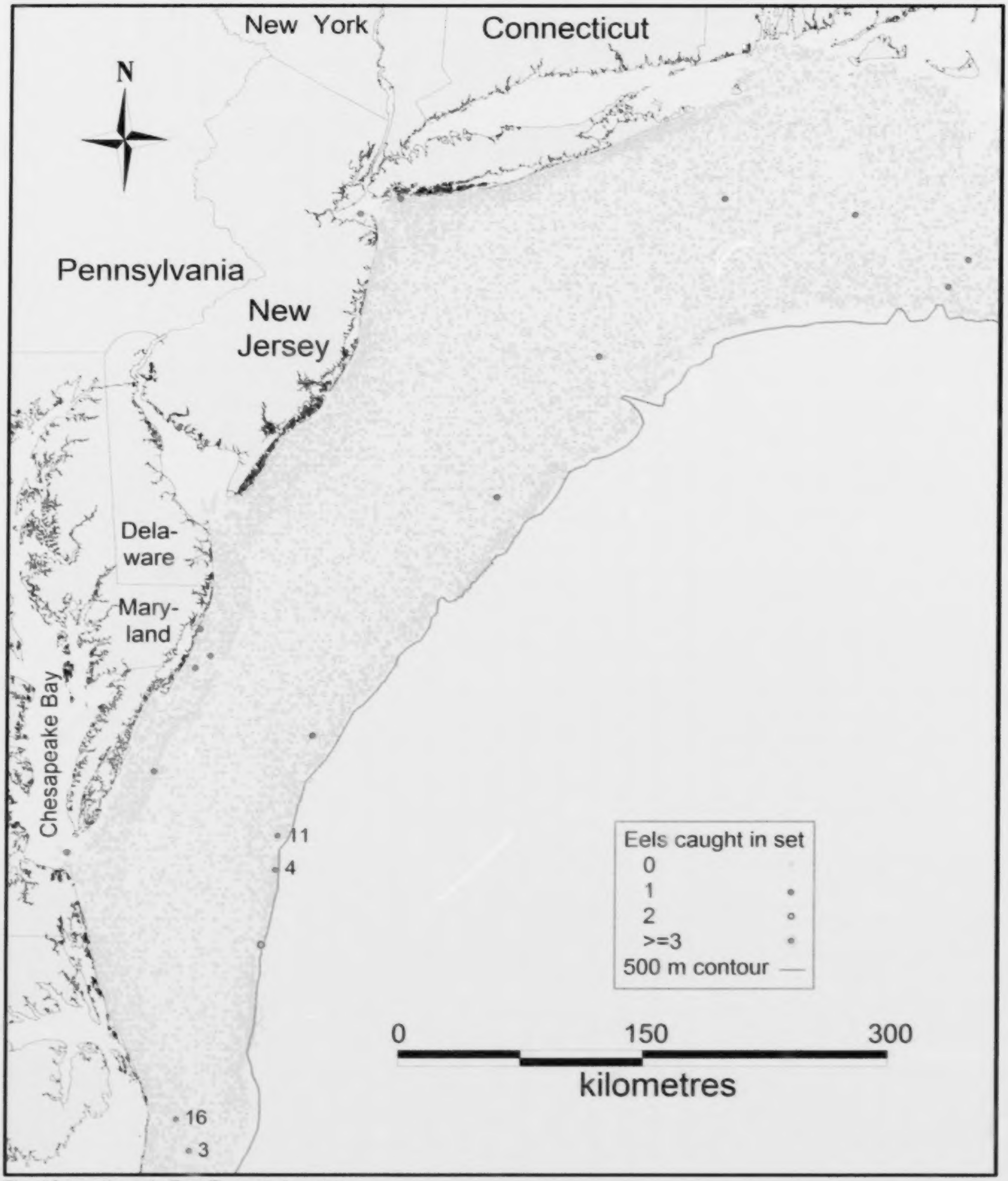


Fig. 13 (continued). Part B, central sector.

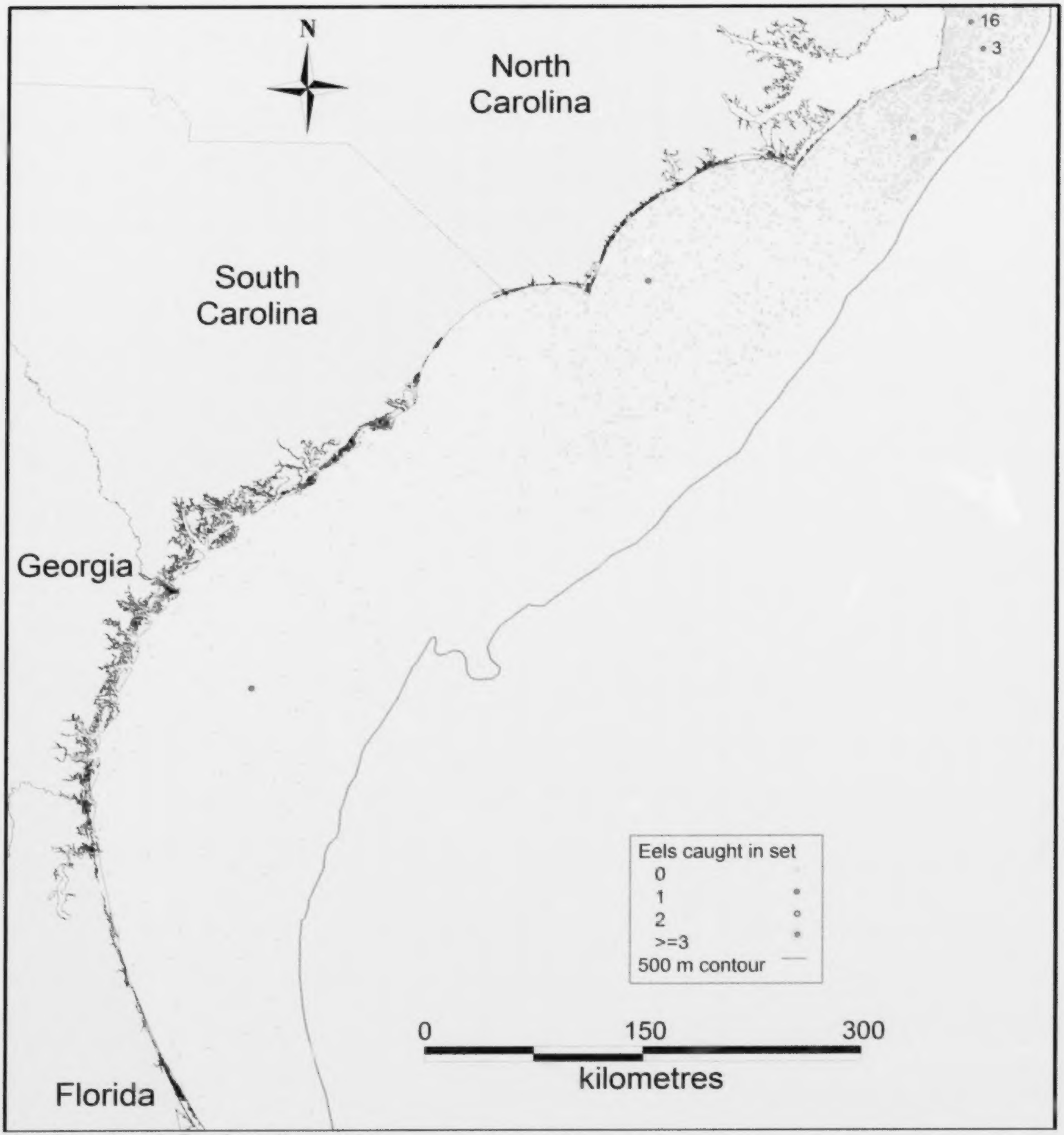


Fig. 13 (continued). Part C, southern sector.

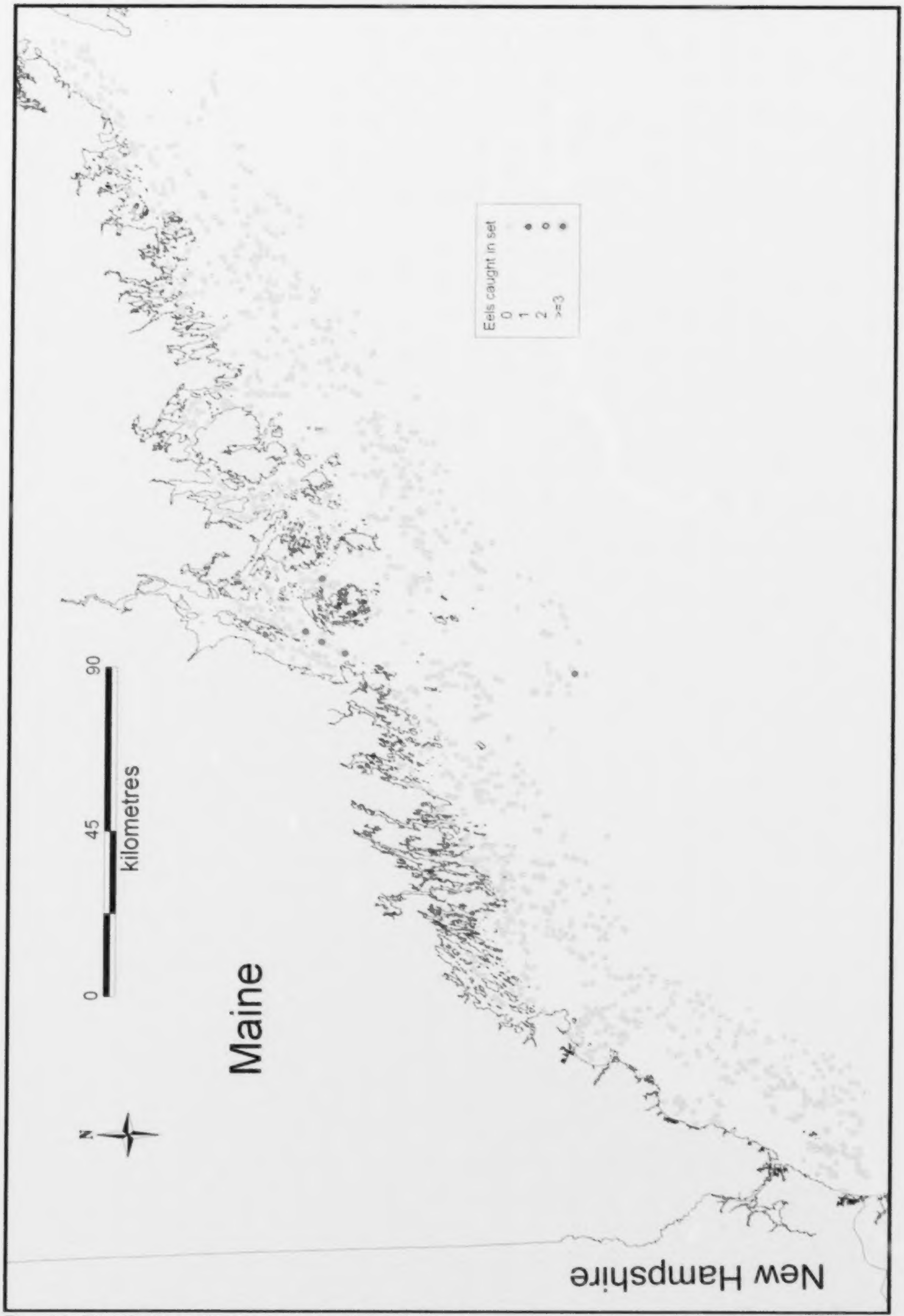


Fig. 14. Distribution of sets, and number of American eels caught per set, in the Maine-New Hampshire Trawl Survey (MENH_T), based on 2,068 sets in 2000-2011.

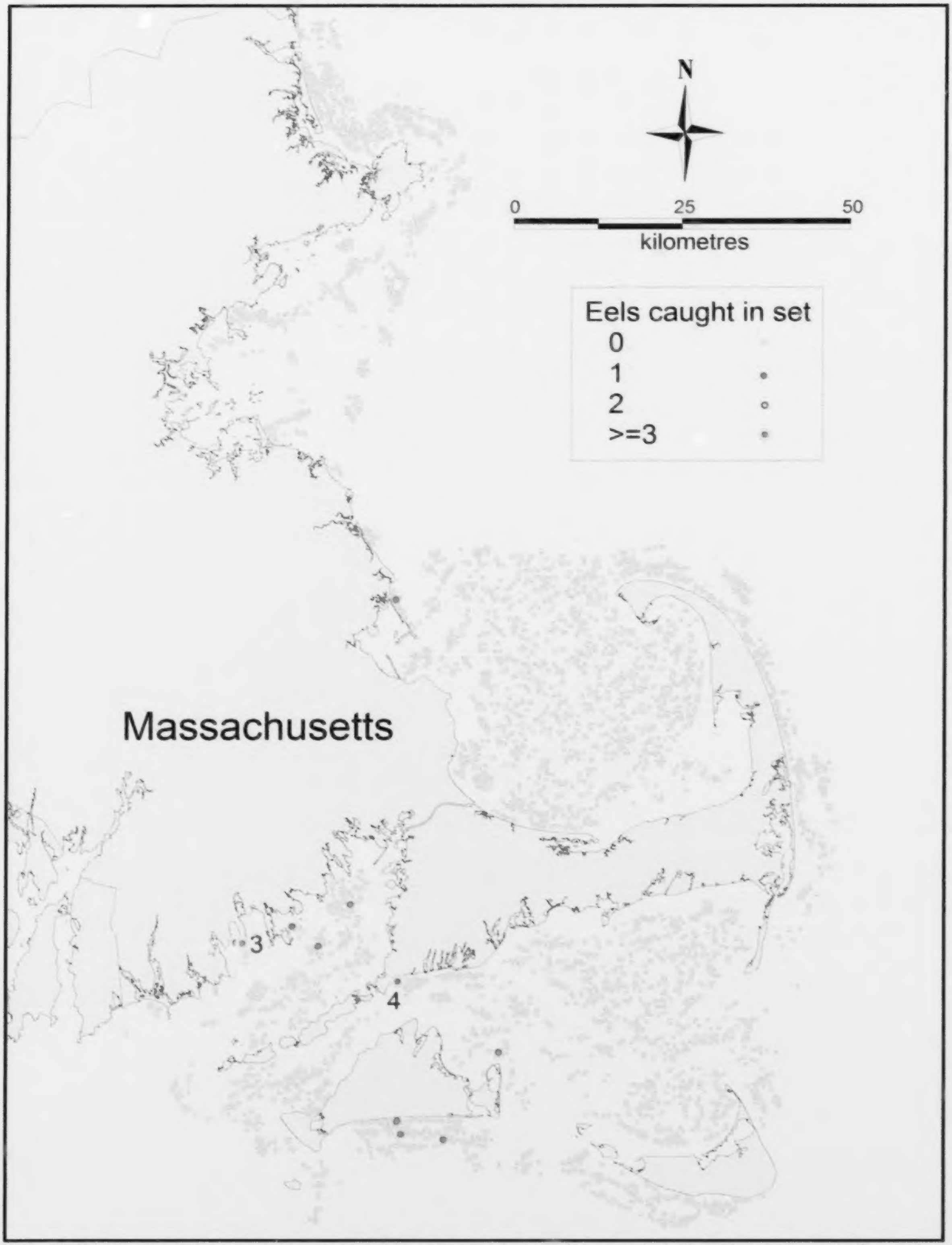


Fig. 15. Distribution of sets, and number of American eels caught per set, in the Massachusetts Trawl Survey (MA_T), based on 6,348 sets in 1978-2011. Numbers adjacent to symbols indicate the number of eels captured.

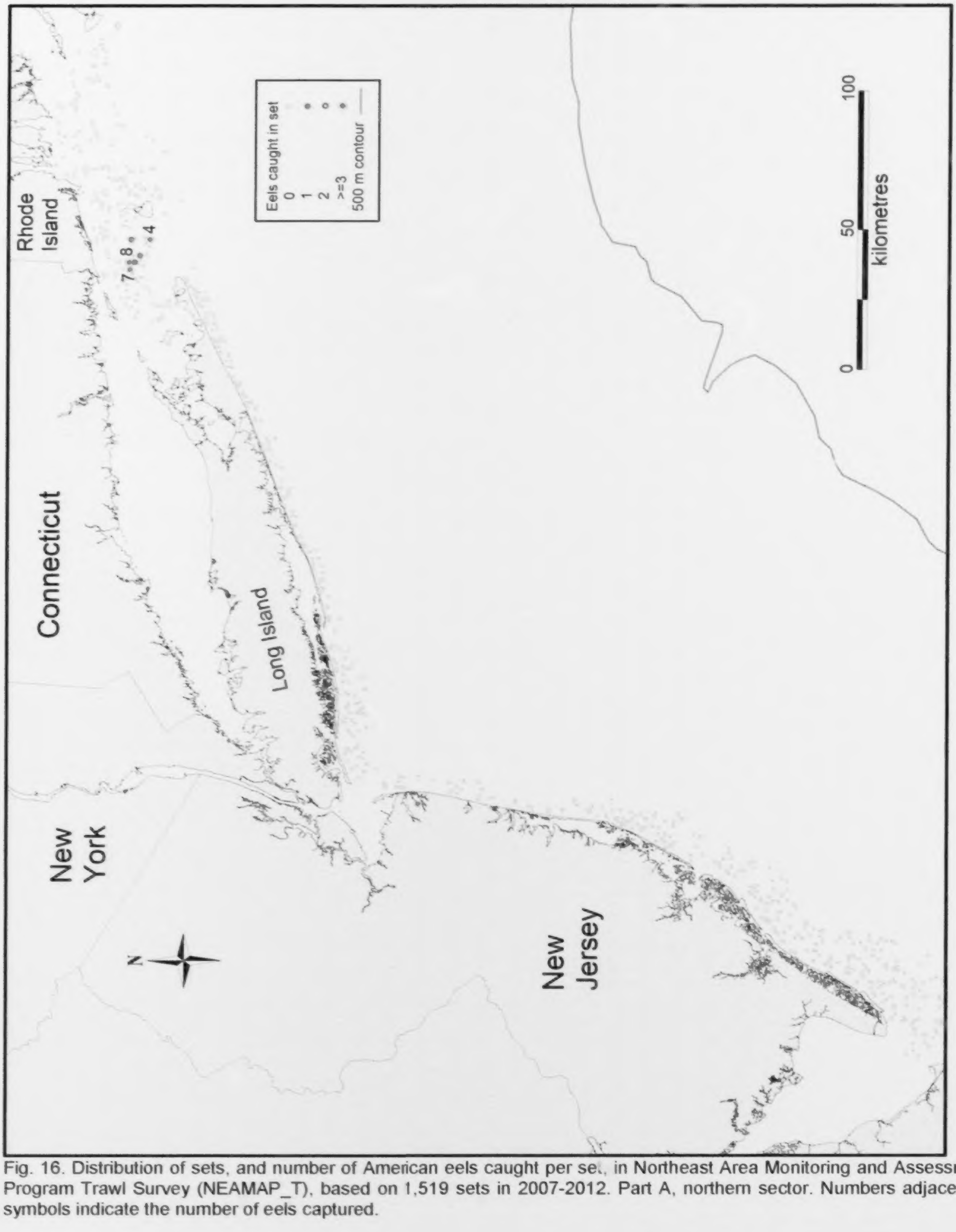


Fig. 16. Distribution of sets, and number of American eels caught per set, in Northeast Area Monitoring and Assessment Program Trawl Survey (NEAMAP_T), based on 1,519 sets in 2007-2012. Part A, northern sector. Numbers adjacent to symbols indicate the number of eels captured.

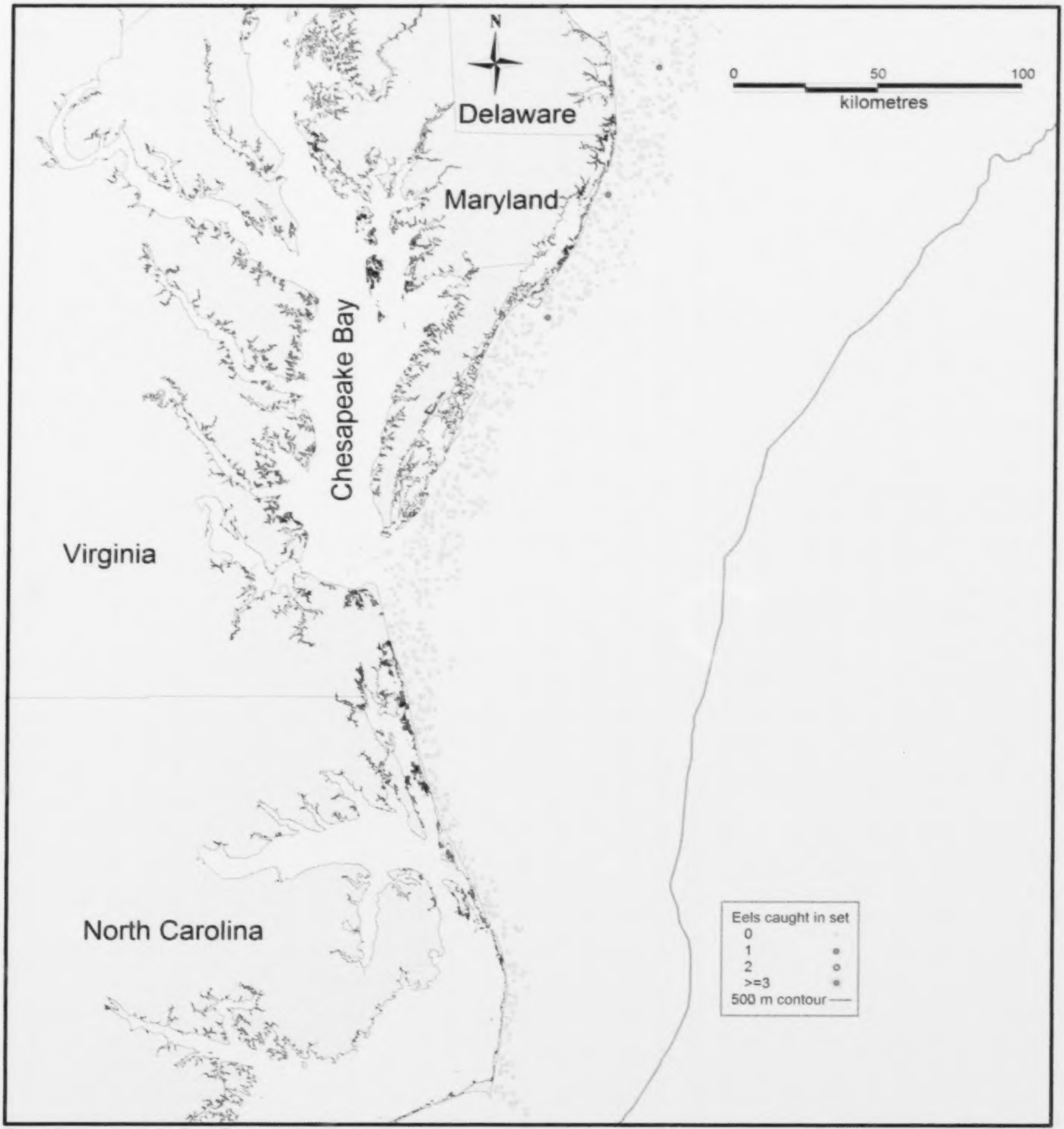


Fig. 16 (continued). Part B, southern sector.

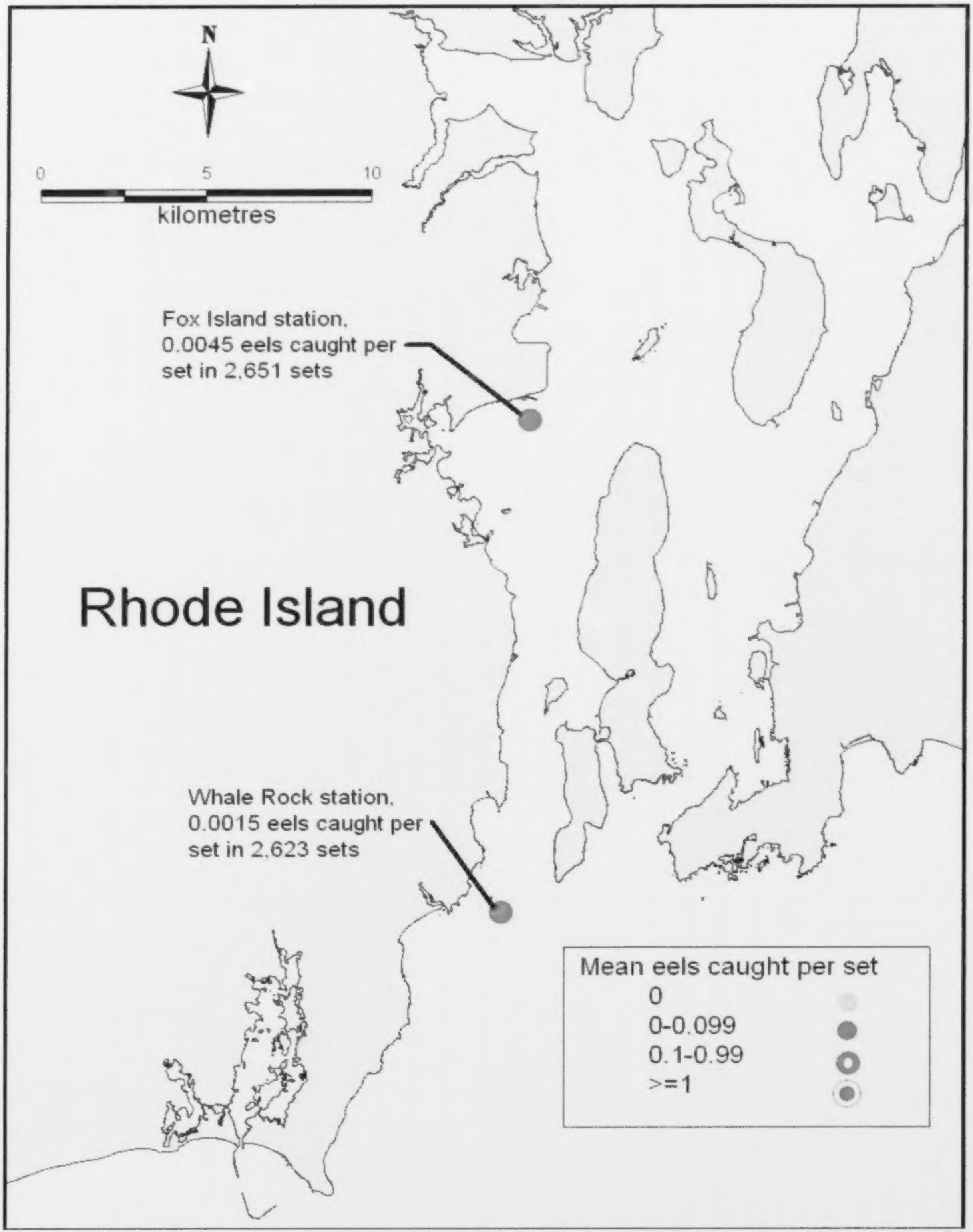


Fig. 17. Distribution of sets, and number of American eels caught per set, in the Rhode Island Trawl Survey (RI_T), based on 5,274 sets in 1959-2012. Each symbol represents multiple sets at a single location.

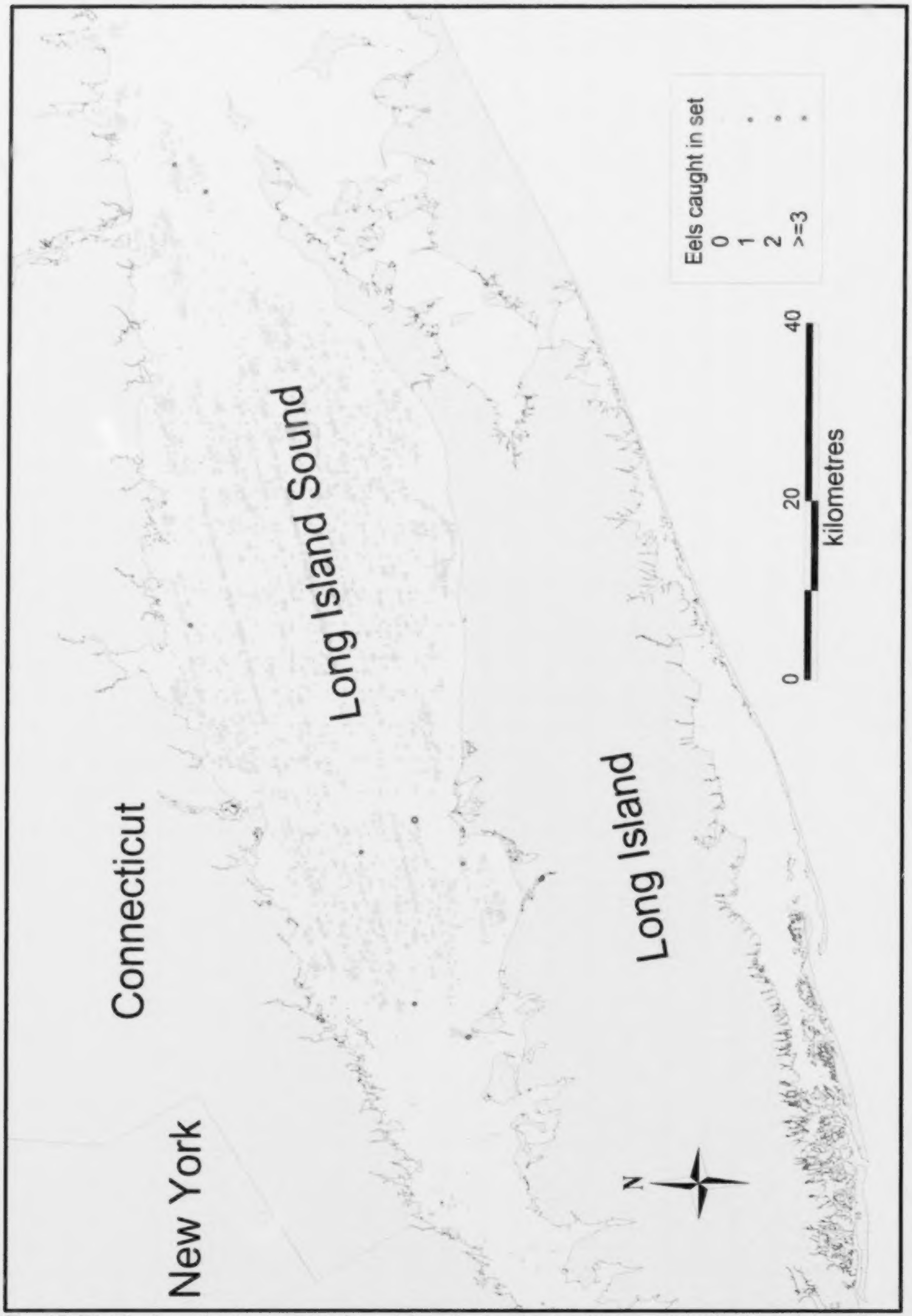


Fig. 18. Distribution of sets, and number of American eels caught per set, in the Long Island Sound Trawl Survey (LIS_T), based on 5,966 sets in 1984-2011.

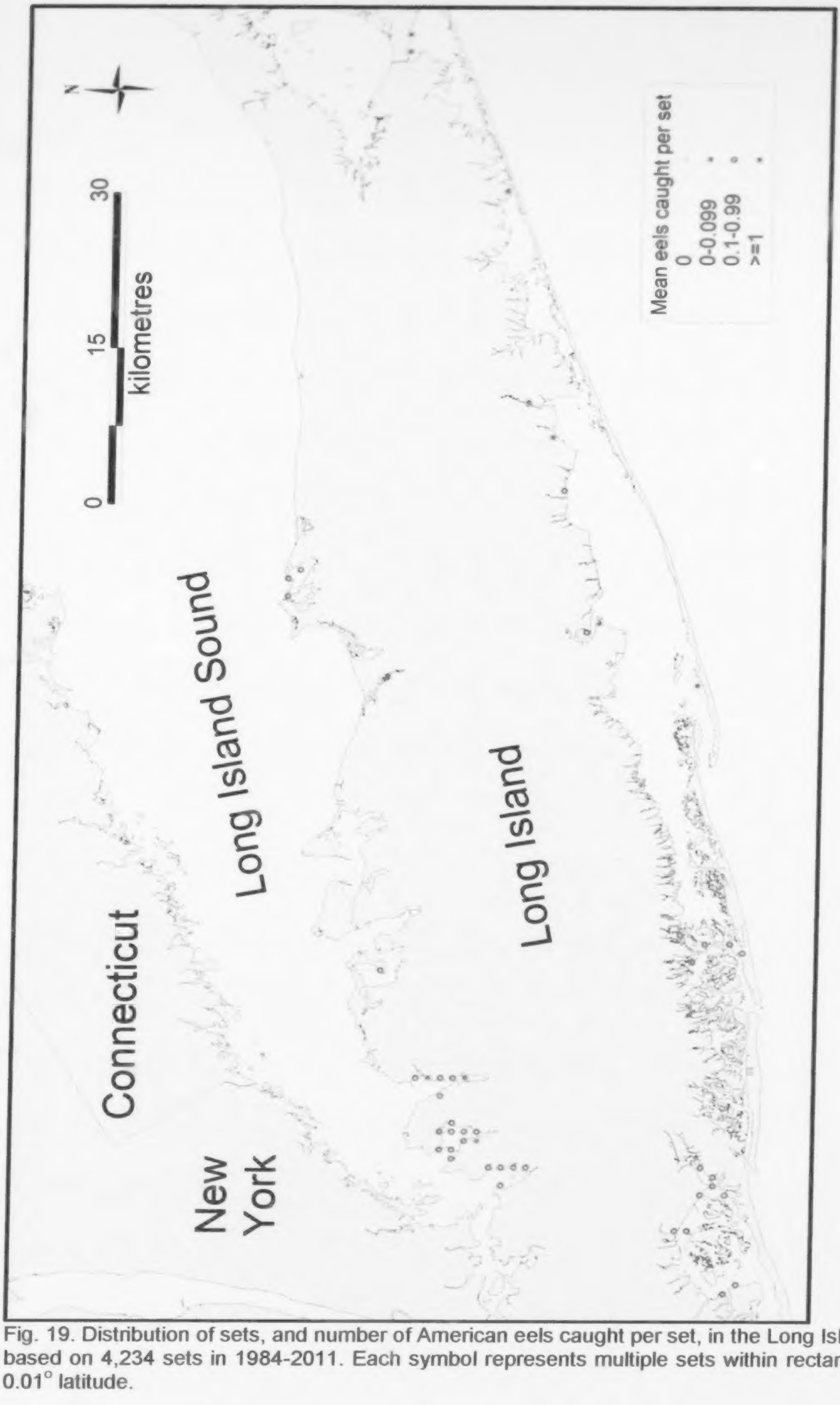


Fig. 19. Distribution of sets, and number of American eels caught per set, in the Long Island Beach Seine Survey (LI_BS), based on 4,234 sets in 1984-2011. Each symbol represents multiple sets within rectangles measuring 0.01° longitude x 0.01° latitude.

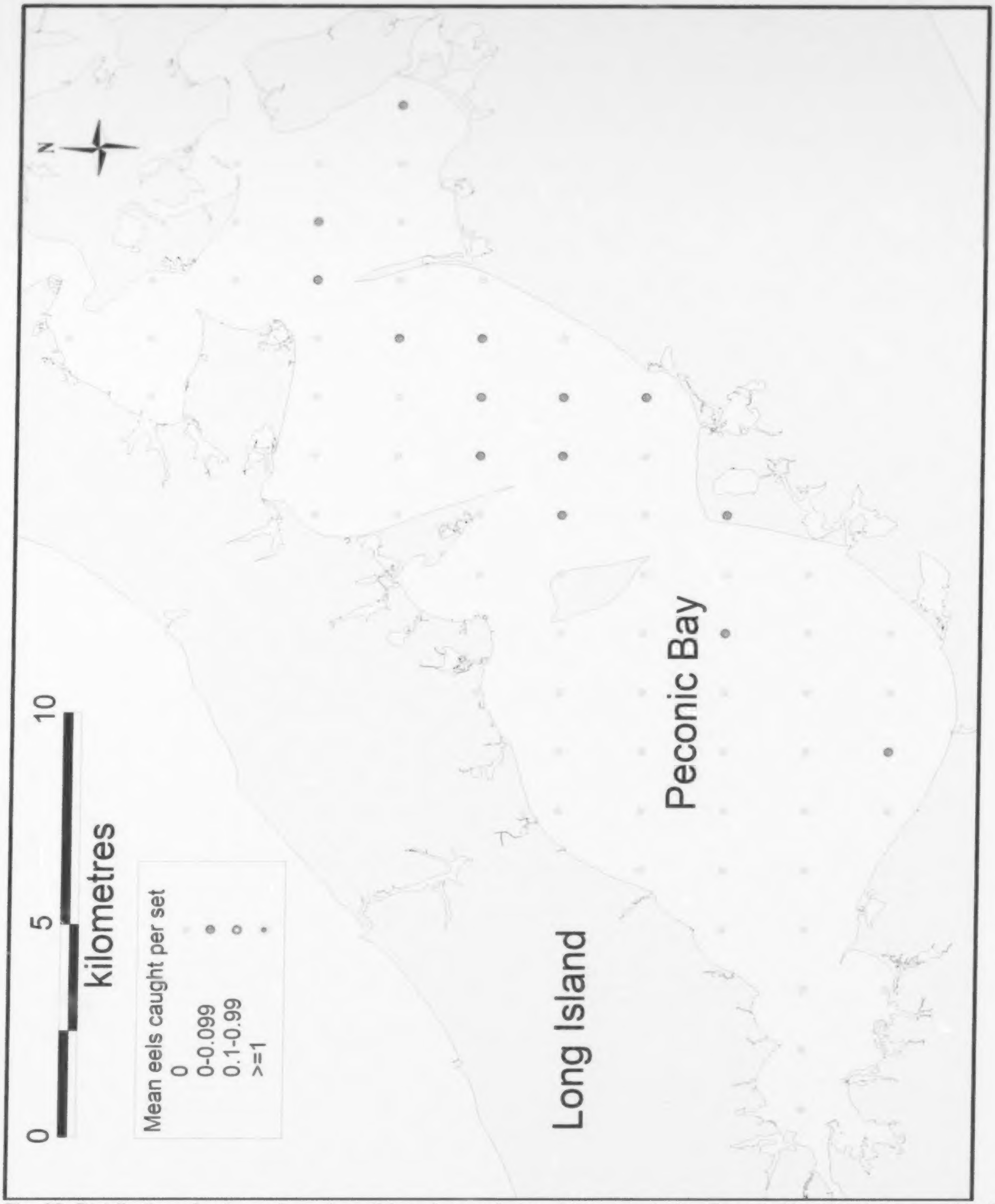


Fig. 20. Distribution of sets, and number of American eels caught per set, in the Peconic Bay Trawl Survey (PB_T), based on 7,811 sets in 1987-2010. Each symbol represents multiple sets.

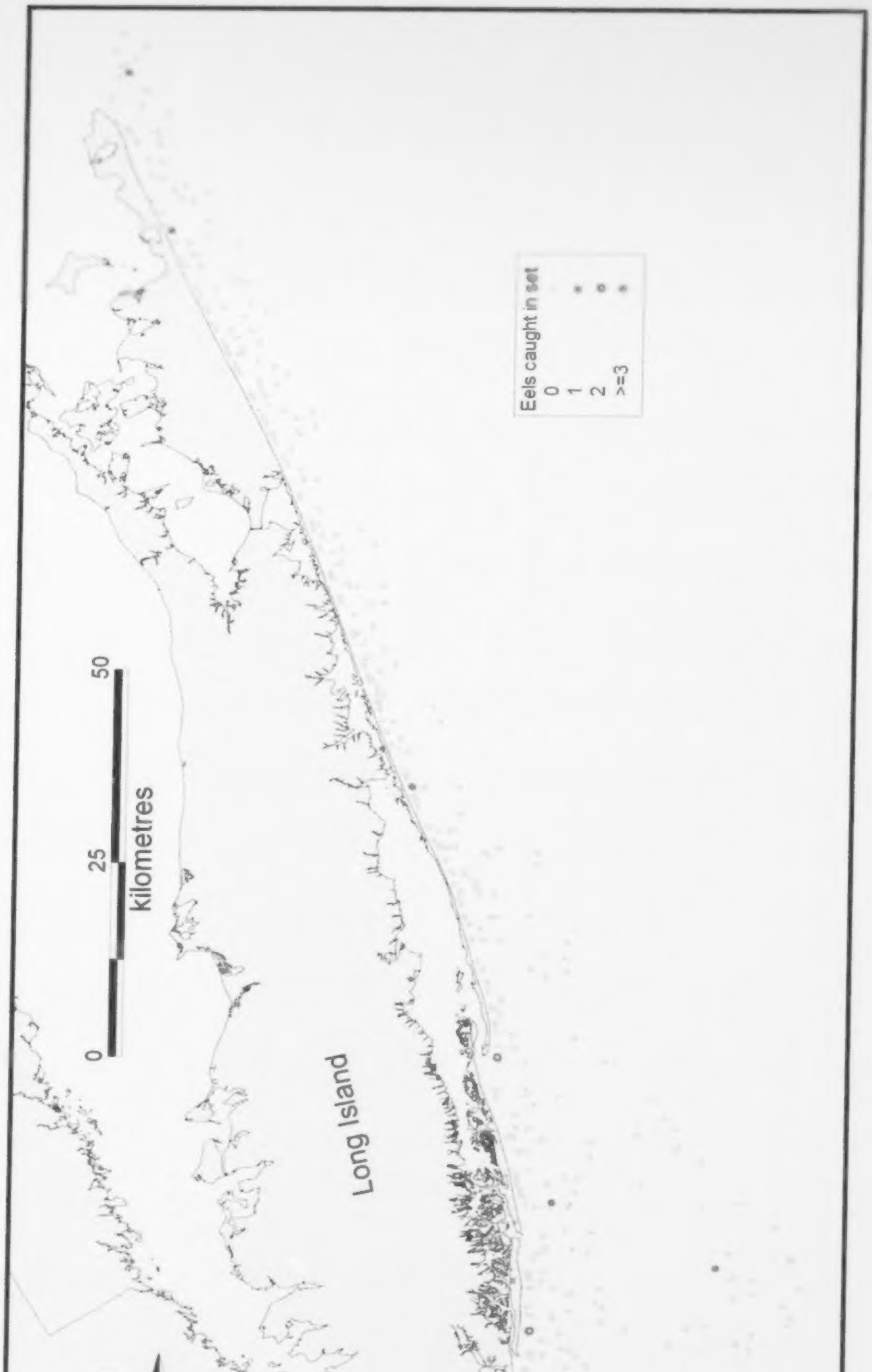


Fig. 21. Distribution of sets, and number of American eels caught per set, in the Long Island Atlantic Trawl Survey (LIA_T), based on 543 sets in 2005-2007.

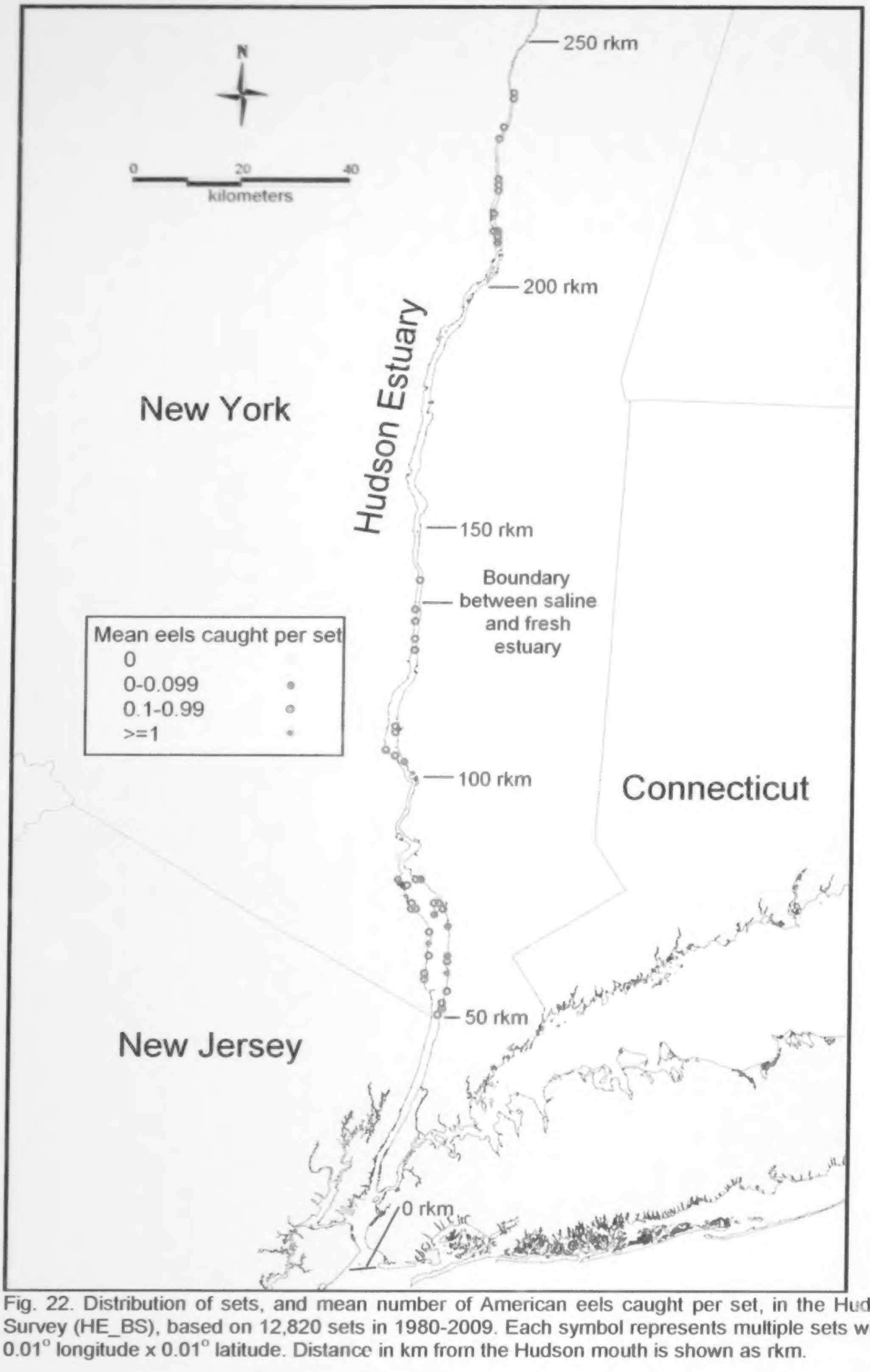


Fig. 22. Distribution of sets, and mean number of American eels caught per set, in the Hudson Estuary Beach Seine Survey (HE_BS), based on 12,820 sets in 1980-2009. Each symbol represents multiple sets within rectangles measuring 0.01° longitude x 0.01° latitude. Distance in km from the Hudson mouth is shown as rkm.

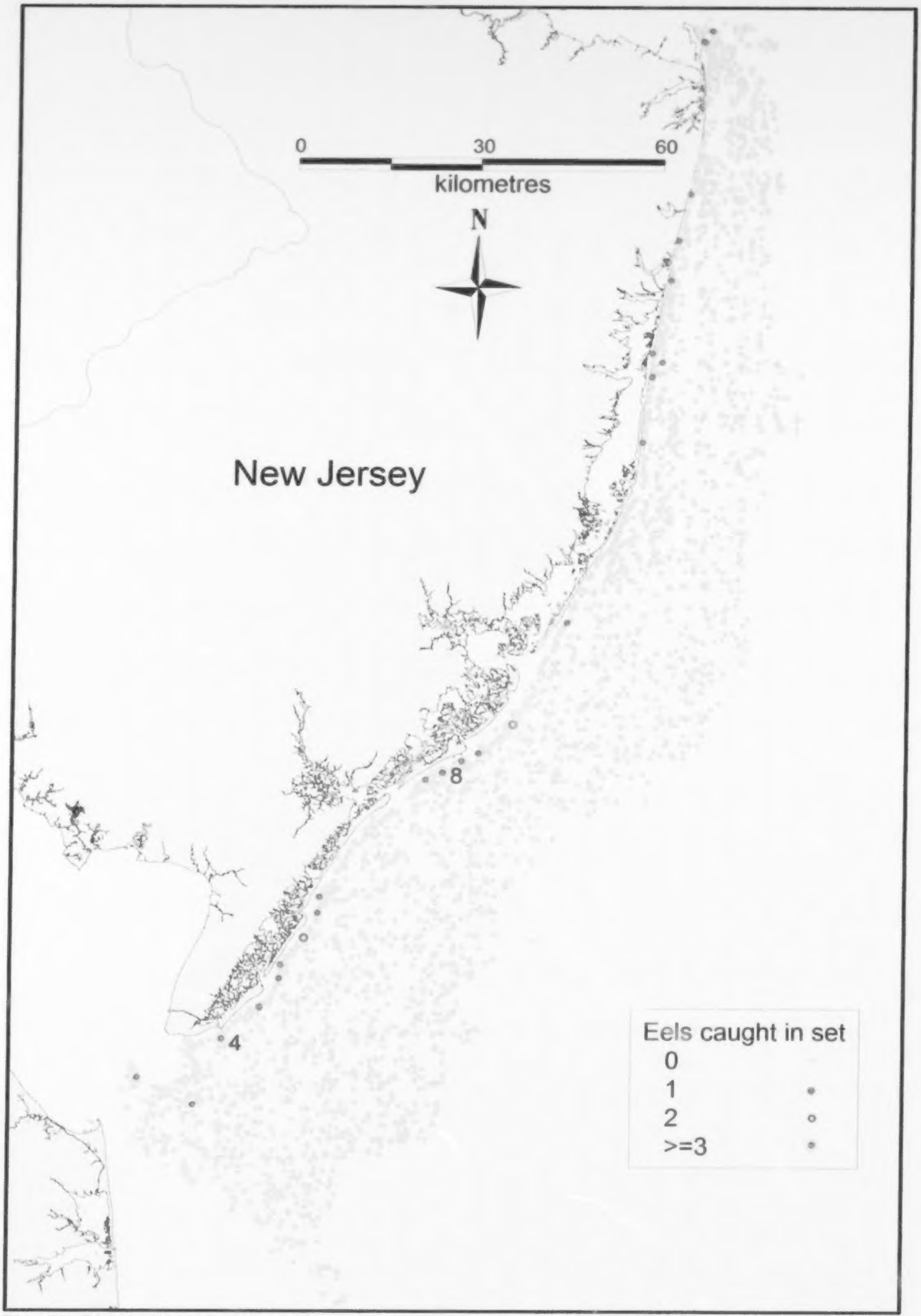


Fig. 23 Distribution of sets, and number of American eels caught per set, in the New Jersey Atlantic Trawl Survey (NJA_T), based on 4,427 sets in 1988-2012. Numbers adjacent to symbols indicate the number of eels captured.

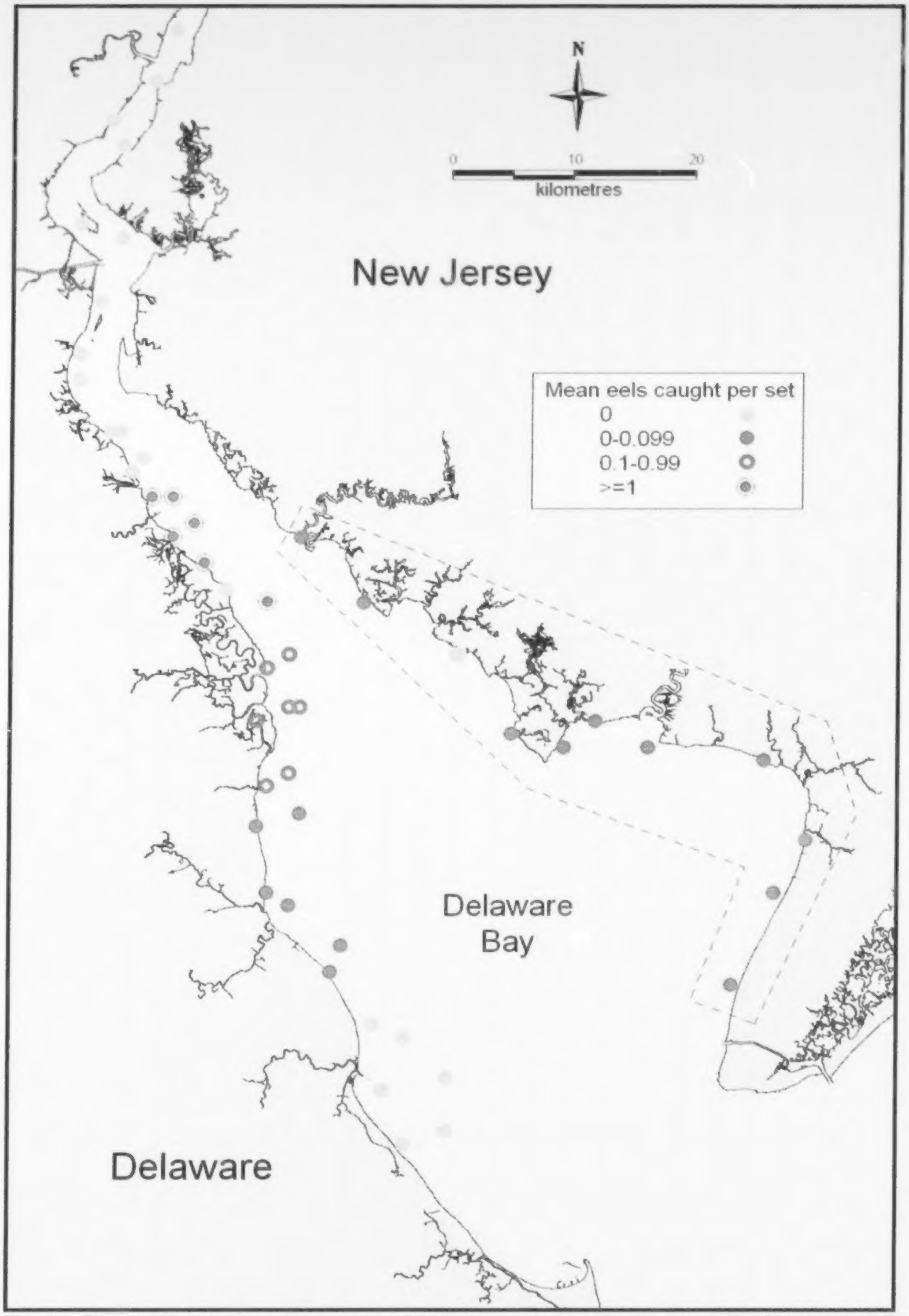


Fig. 24. Distribution of sets, and number of American eels caught per set, in the New Jersey Delaware Bay Trawl Survey (NJDB_T) (inside the dashed line) and in the Delaware Delaware Bay Juvenile Finfish Trawl Survey (DEDB_T) (outside the dashed line), based on 1,549 sets in 1991-2011 for NJDB_T and 8,059 sets in 1978-2009 for DEDB_T. Each symbol represents 1 to several sets within rectangles measuring 0.01° longitude x 0.01° latitude.

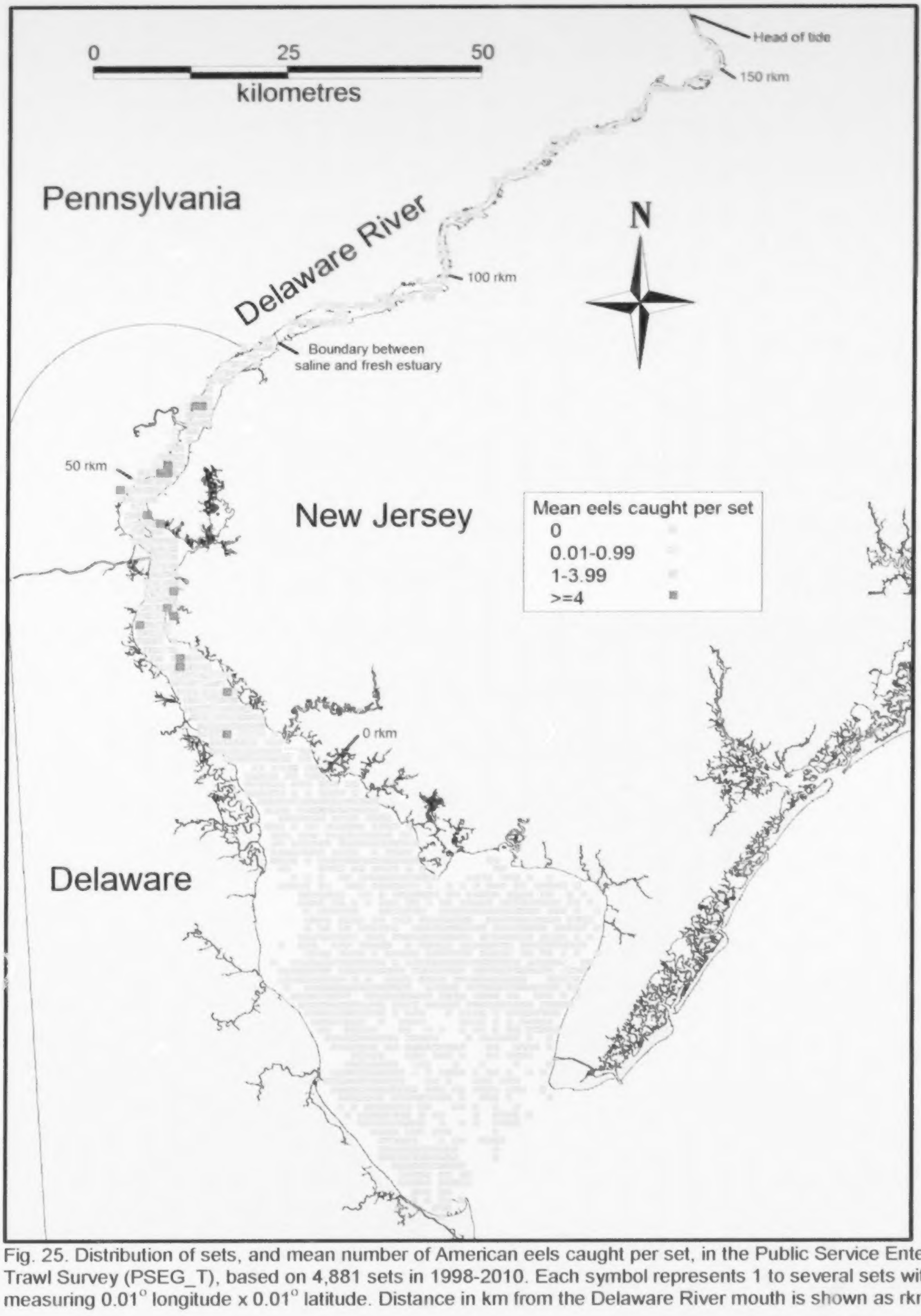


Fig. 25. Distribution of sets, and mean number of American eels caught per set, in the Public Service Enterprise Group Trawl Survey (PSEG_T), based on 4,881 sets in 1998-2010. Each symbol represents 1 to several sets within rectangles measuring 0.01° longitude x 0.01° latitude. Distance in km from the Delaware River mouth is shown as rkm.

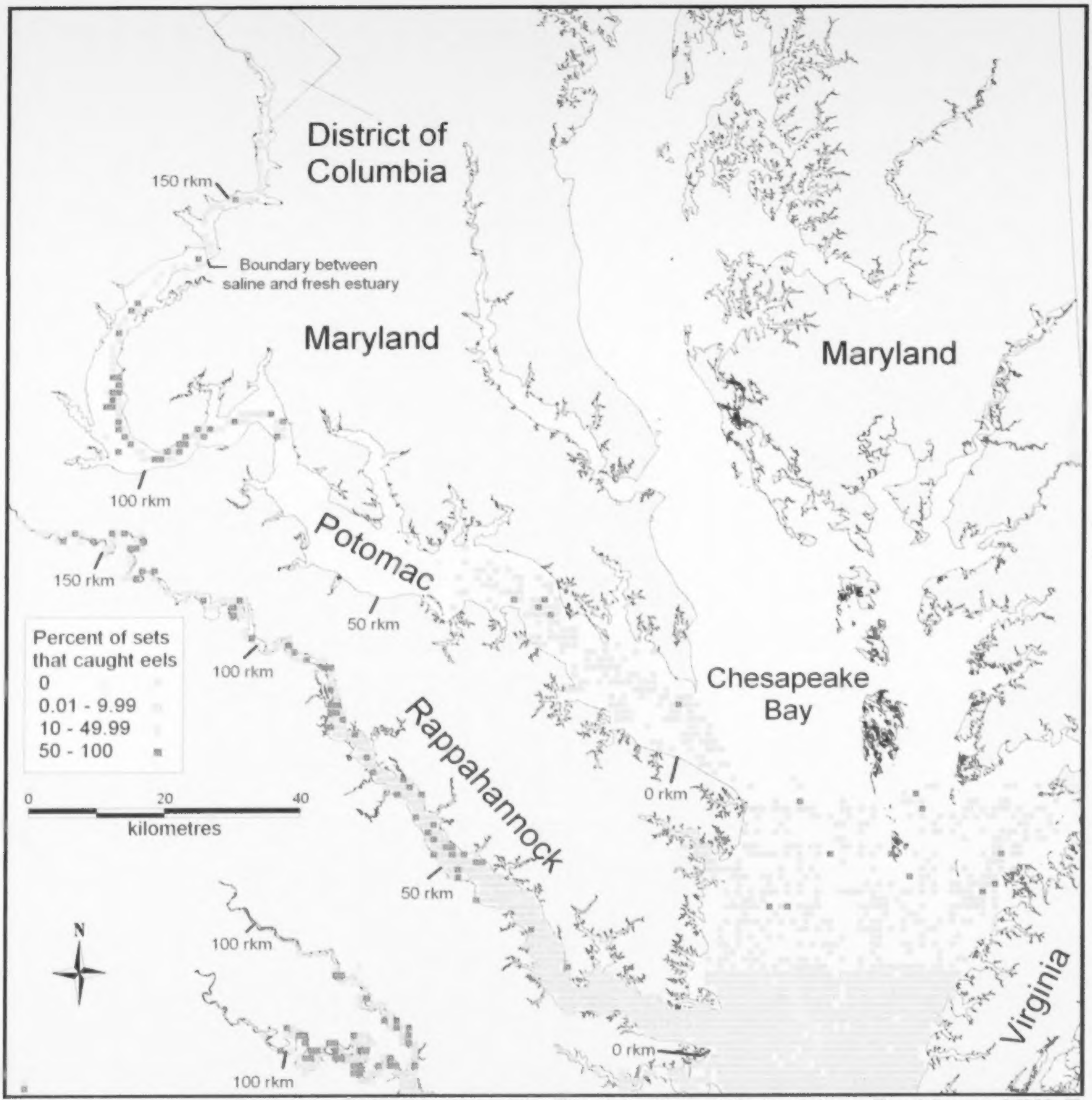


Fig. 26. Percent of sets which captured American eels in the Virginia Institute of Marine Science Trawl Survey (VIMS_T), based on 35,842 sets in 1968-2011. Each symbol represents multiple sets within rectangles measuring 0.01° longitude x 0.01° latitude. Distance in km from the mouth is shown as rkm for the Potomac, Rappahannock, York, and James Rivers. Part A, northern sector.

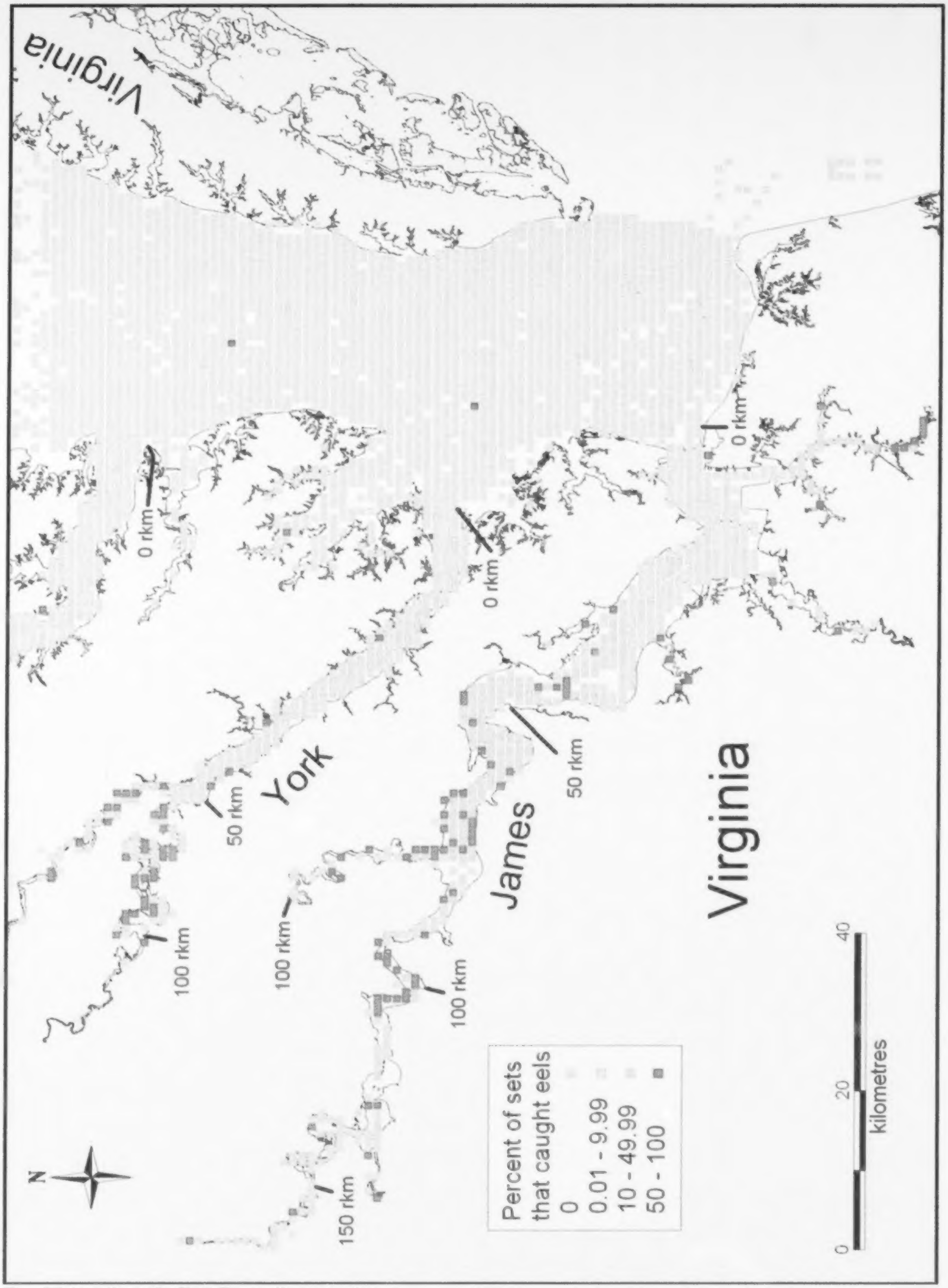


Fig. 26 (continued). Part B, southern sector.

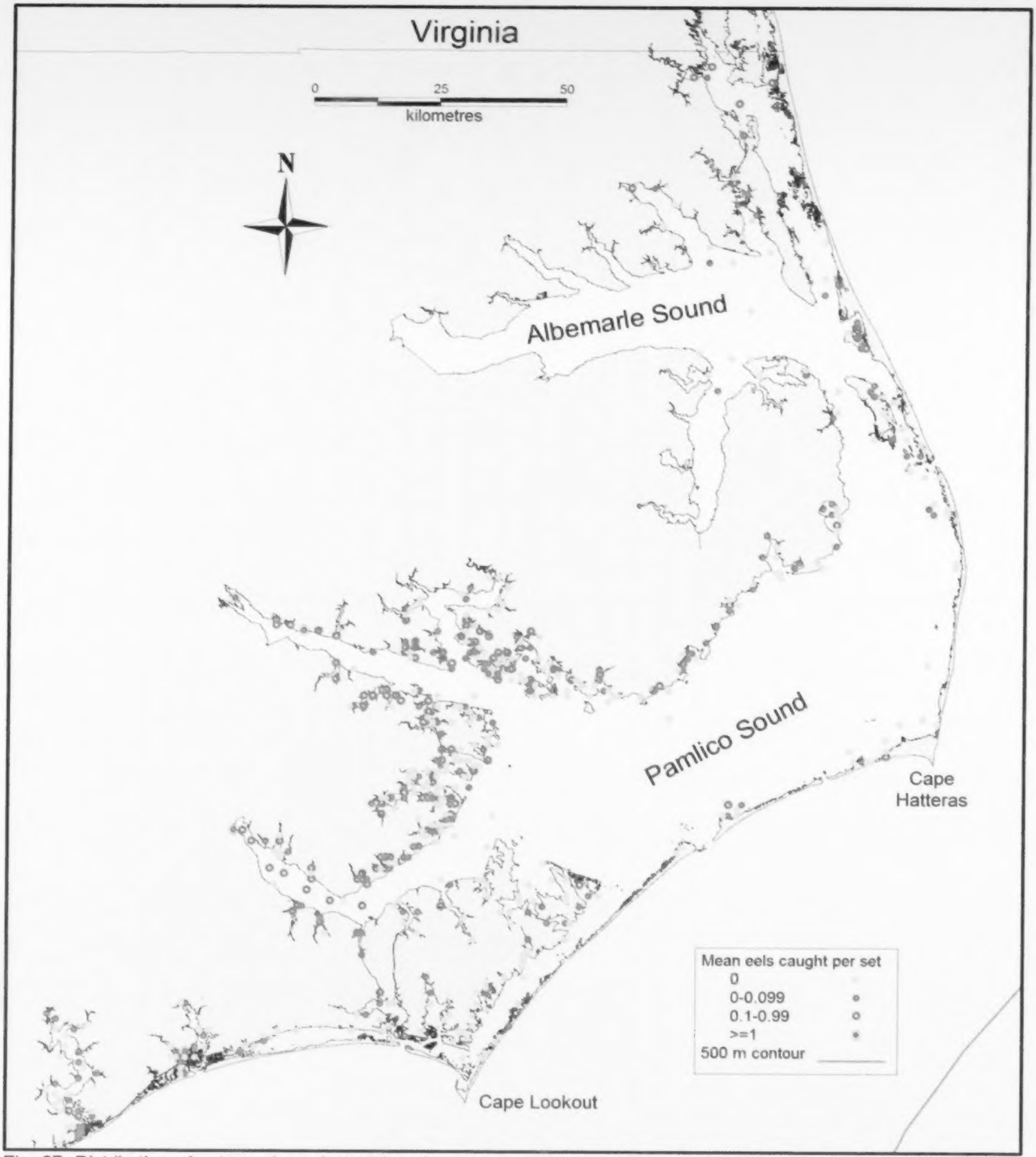


Fig. 27. Distribution of sets, and number of American eels caught per set, in the North Carolina Juvenile Trawl Survey (NCJUV_T), based on 24,001 sets in 1973-2010. Each symbol represents multiple sets within rectangles measuring 0.01° longitude x 0.01° latitude. Part A, Northern Sector.

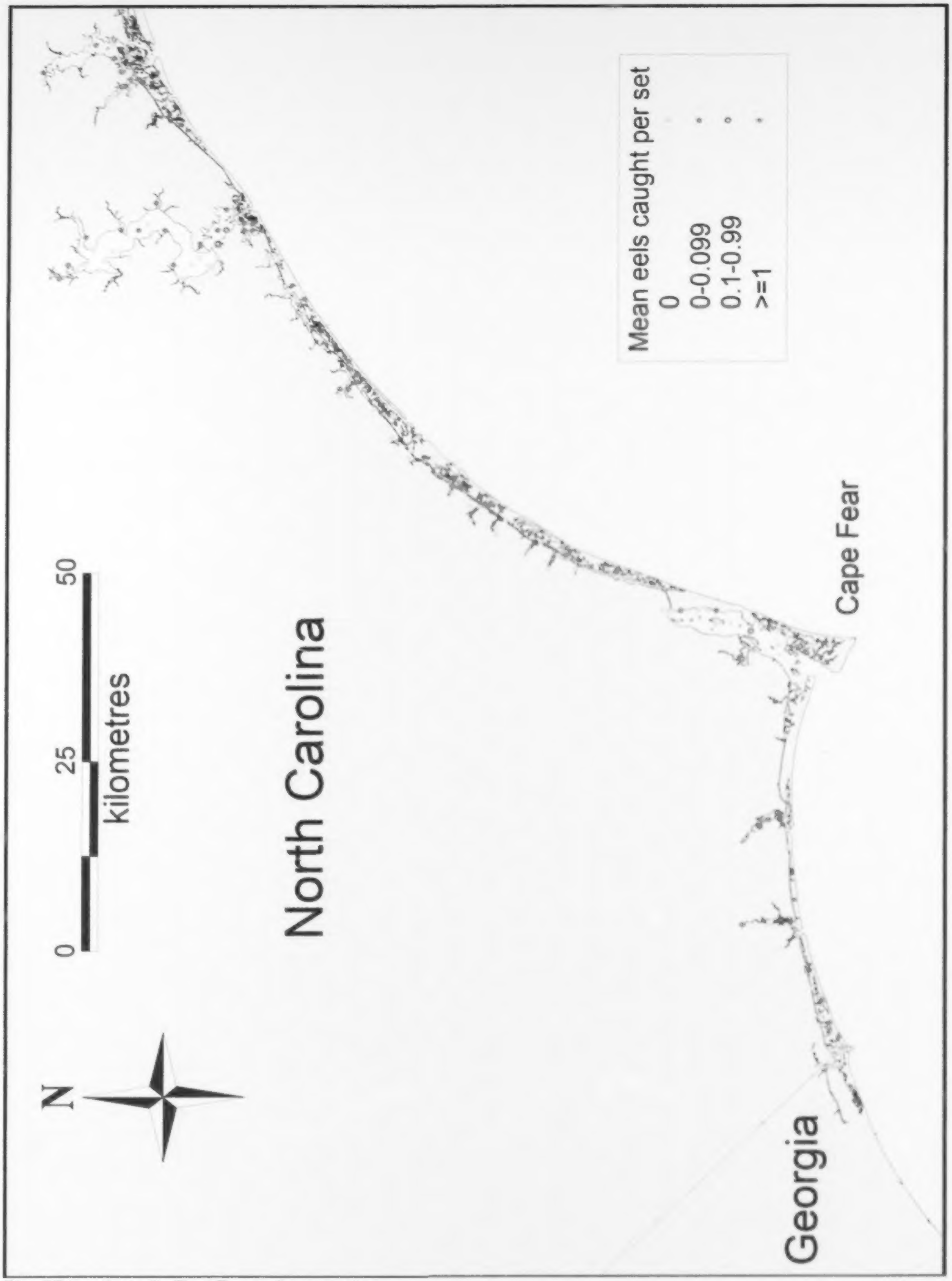


Fig. 27(continued). Part B, southern sector.

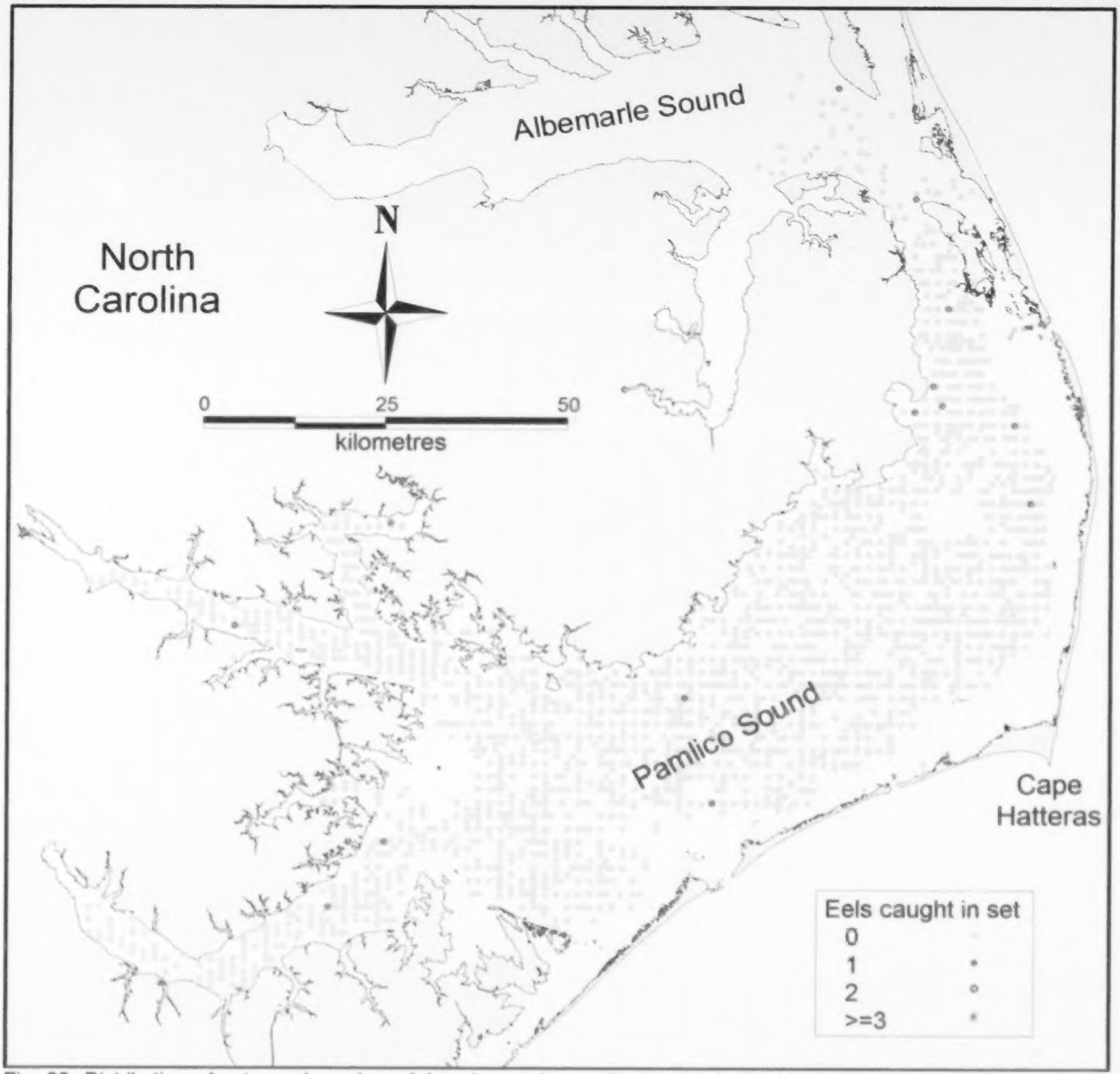


Fig. 28. Distribution of sets, and number of American eels caught per set, in the North Carolina Adult Trawl Survey (NCAD_T), based on 3,200 sets in 1987-2013.

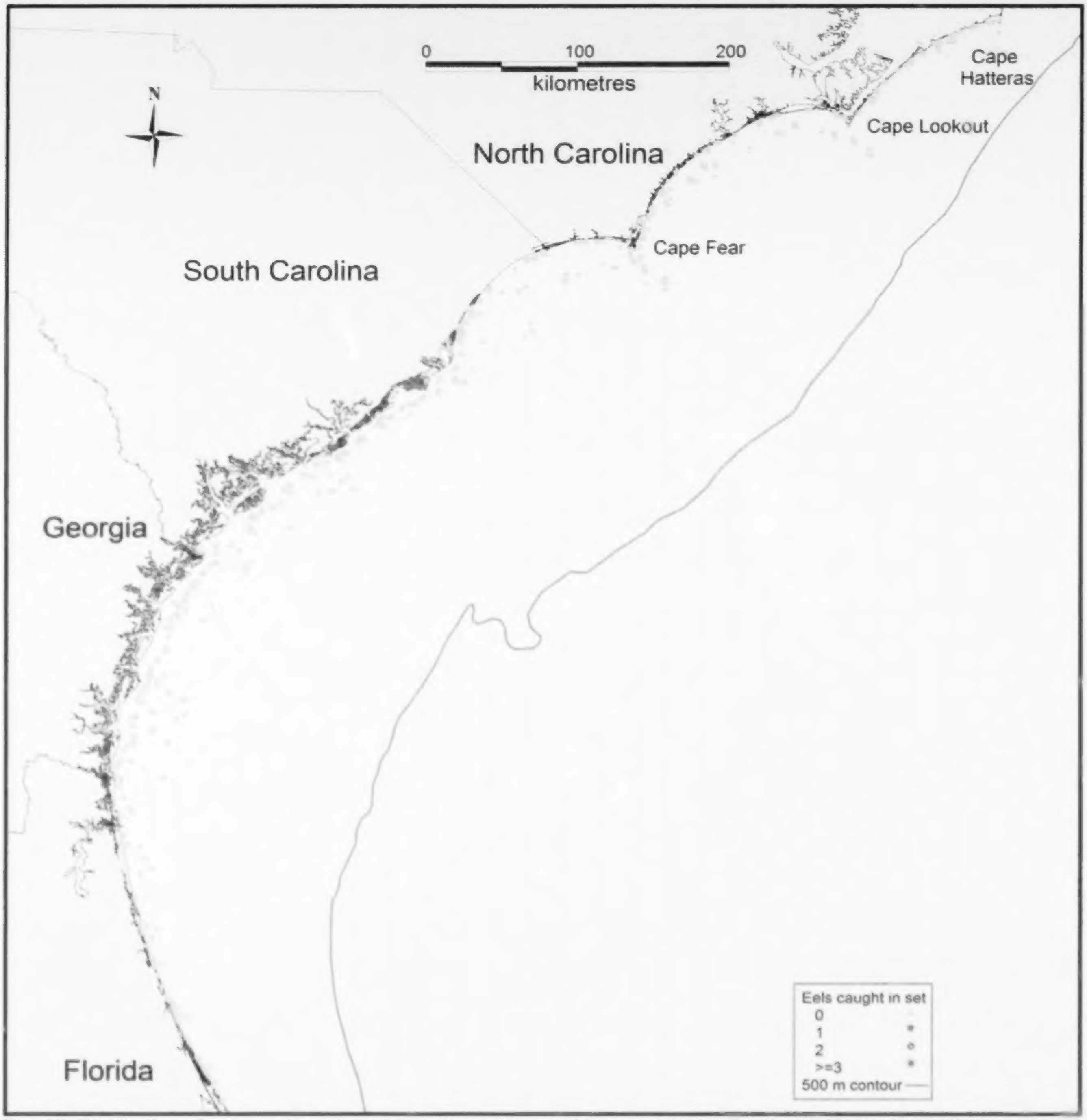


Fig. 29. Distribution of sets, and number of American eels caught per set, in the Southeast Monitoring and Assessment Program (South Atlantic) Trawl Survey (SEAMAP_T), based on 6,754 sets in 1989-2011.

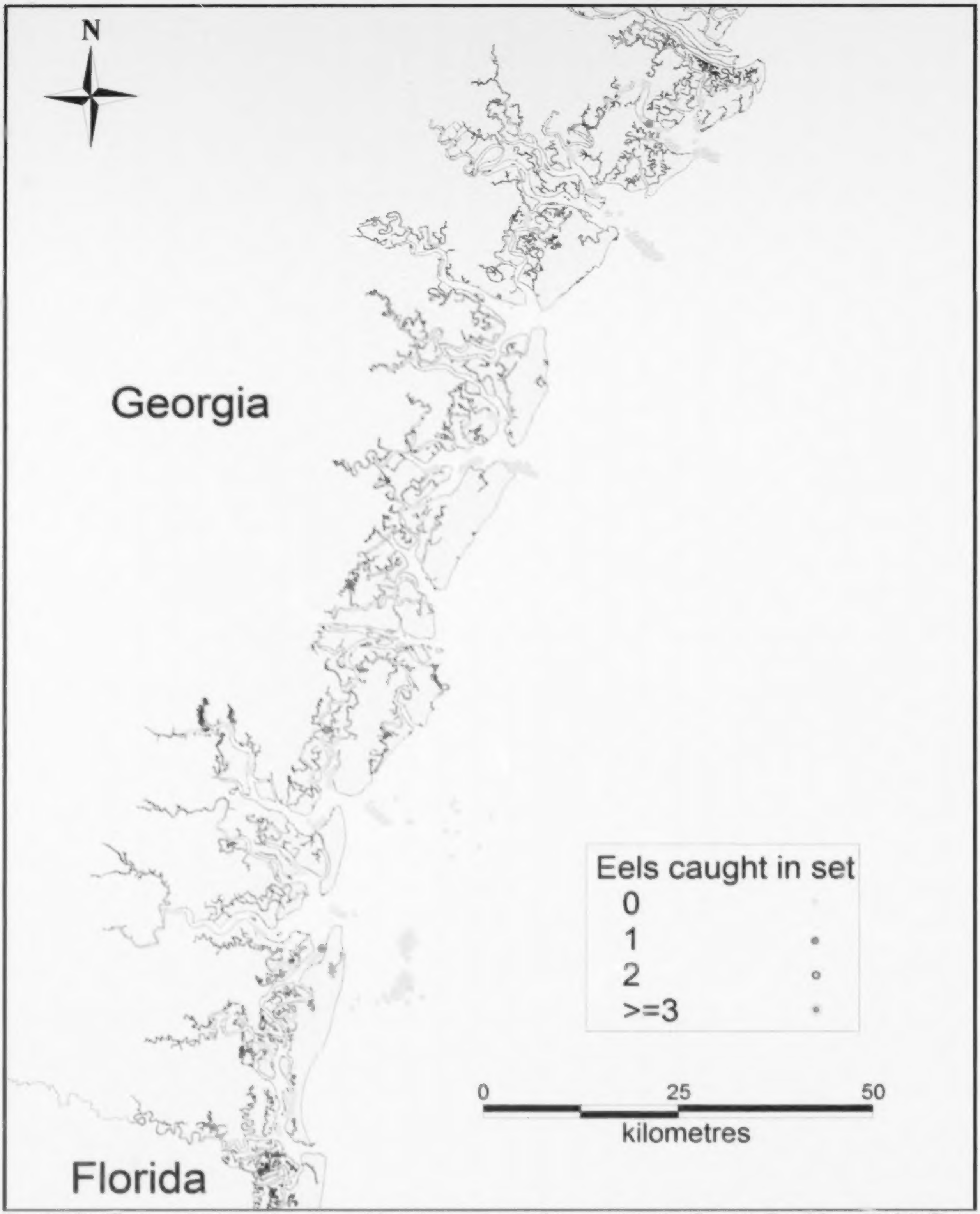


Fig. 30. Distribution of sets, and number of American eels caught per set, in the Georgia Trawl Survey (GA_T), based on 4,210 sets in 2003-2011.

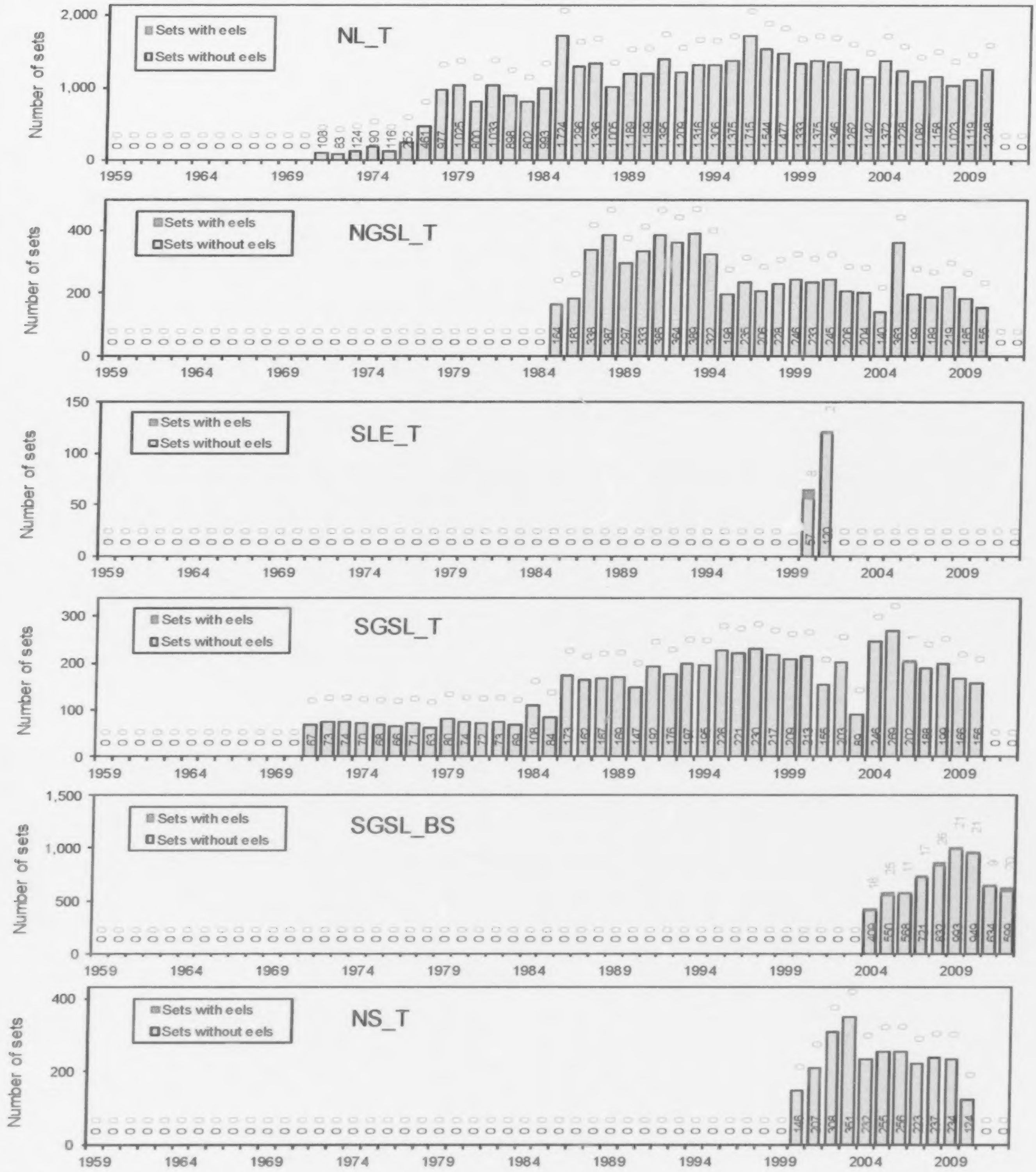


Fig. 31. Number of research survey sets by year. Numbers of sets with eels are shown in red font and numbers of sets without eels are shown in black font.

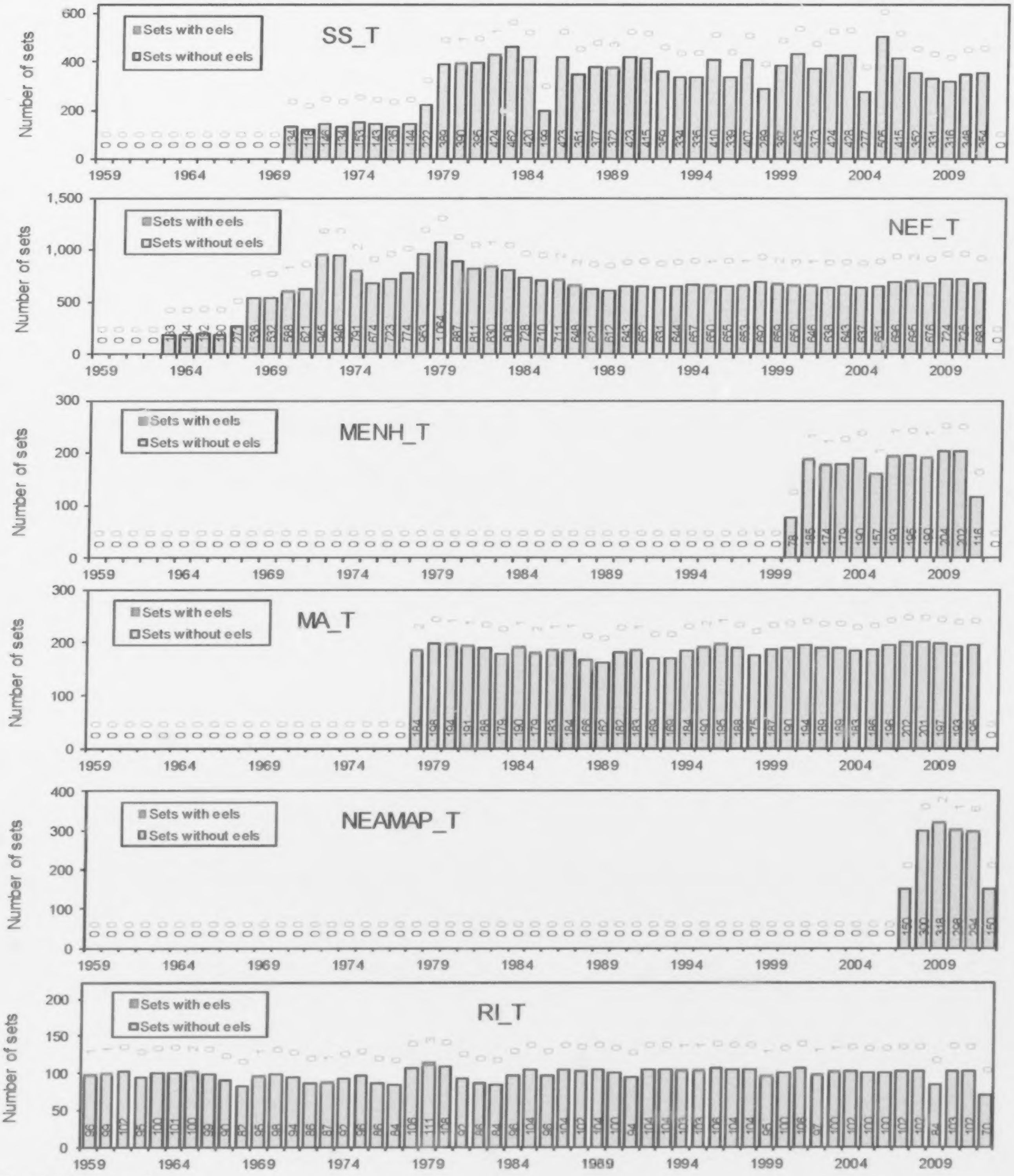


Fig. 31 (continued)

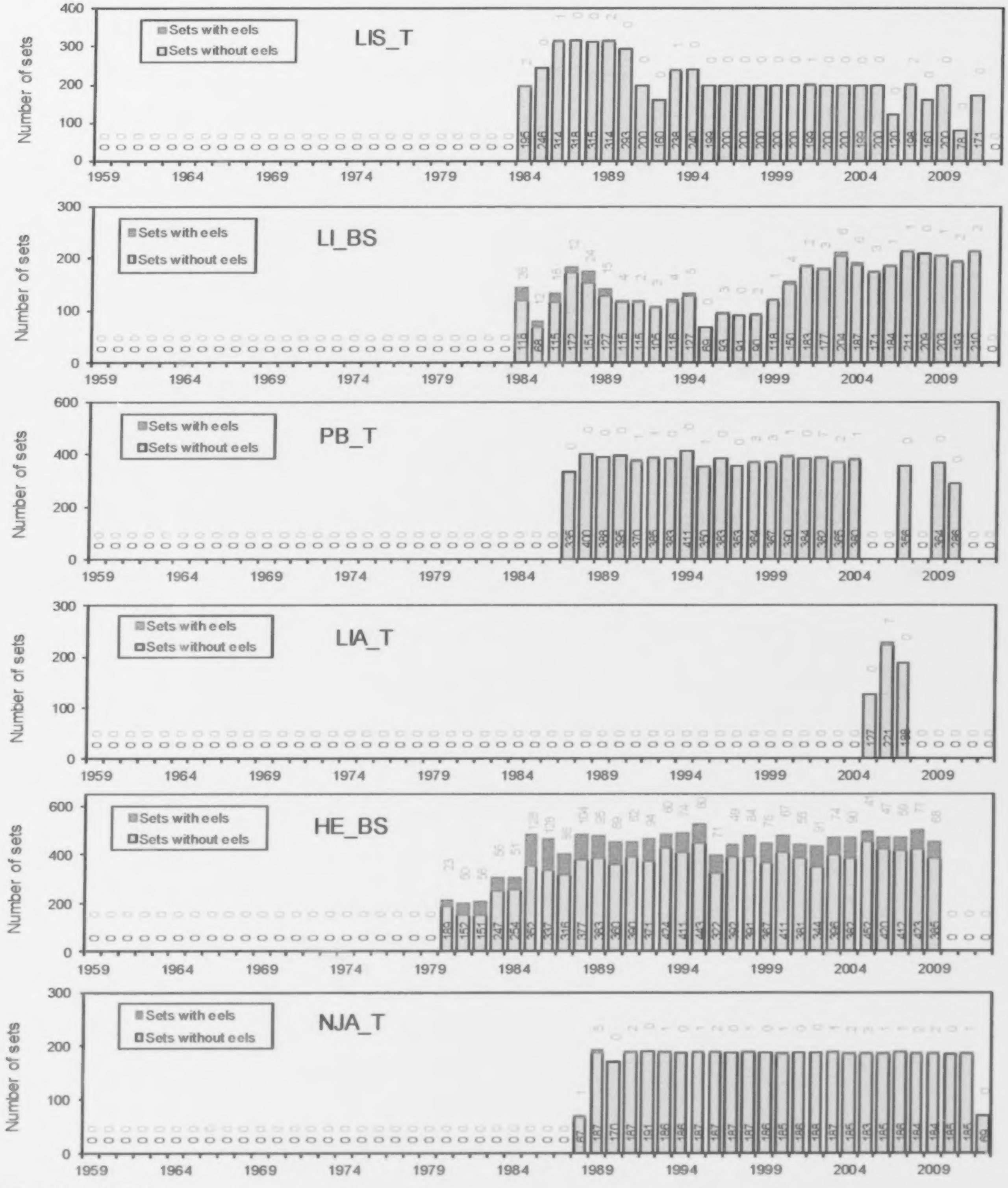


Fig. 31 (continued)

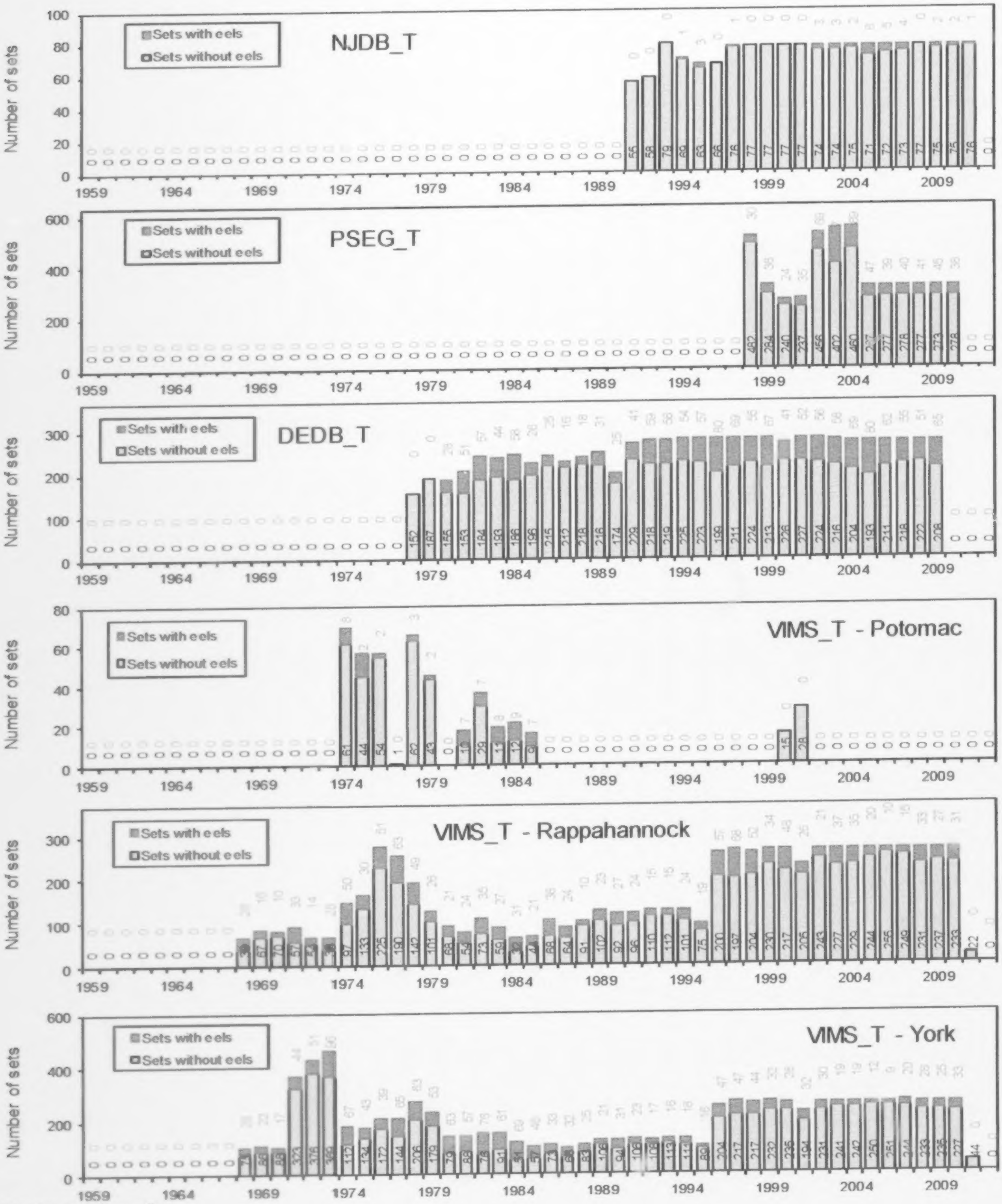


Fig. 31 (continued)

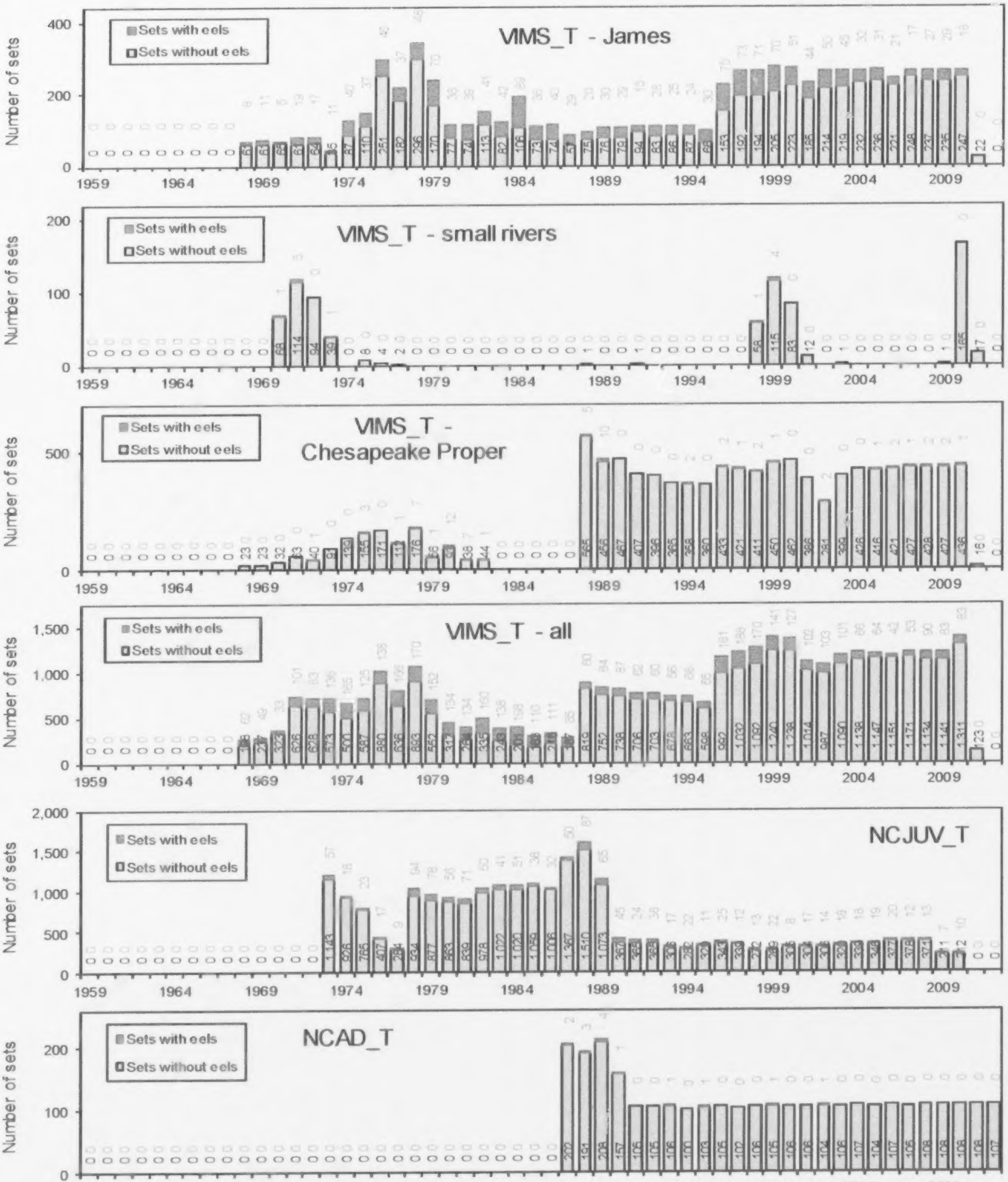


Fig. 31 (continued)

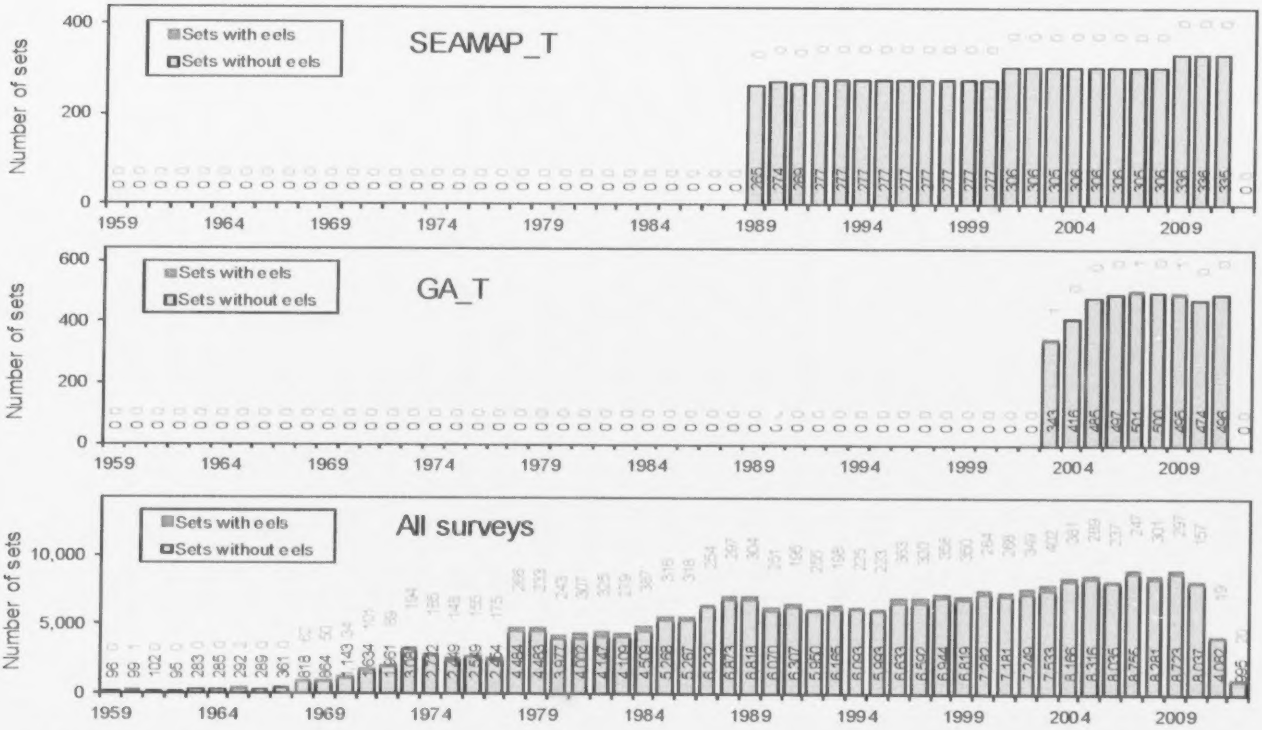


Fig. 31 (continued)

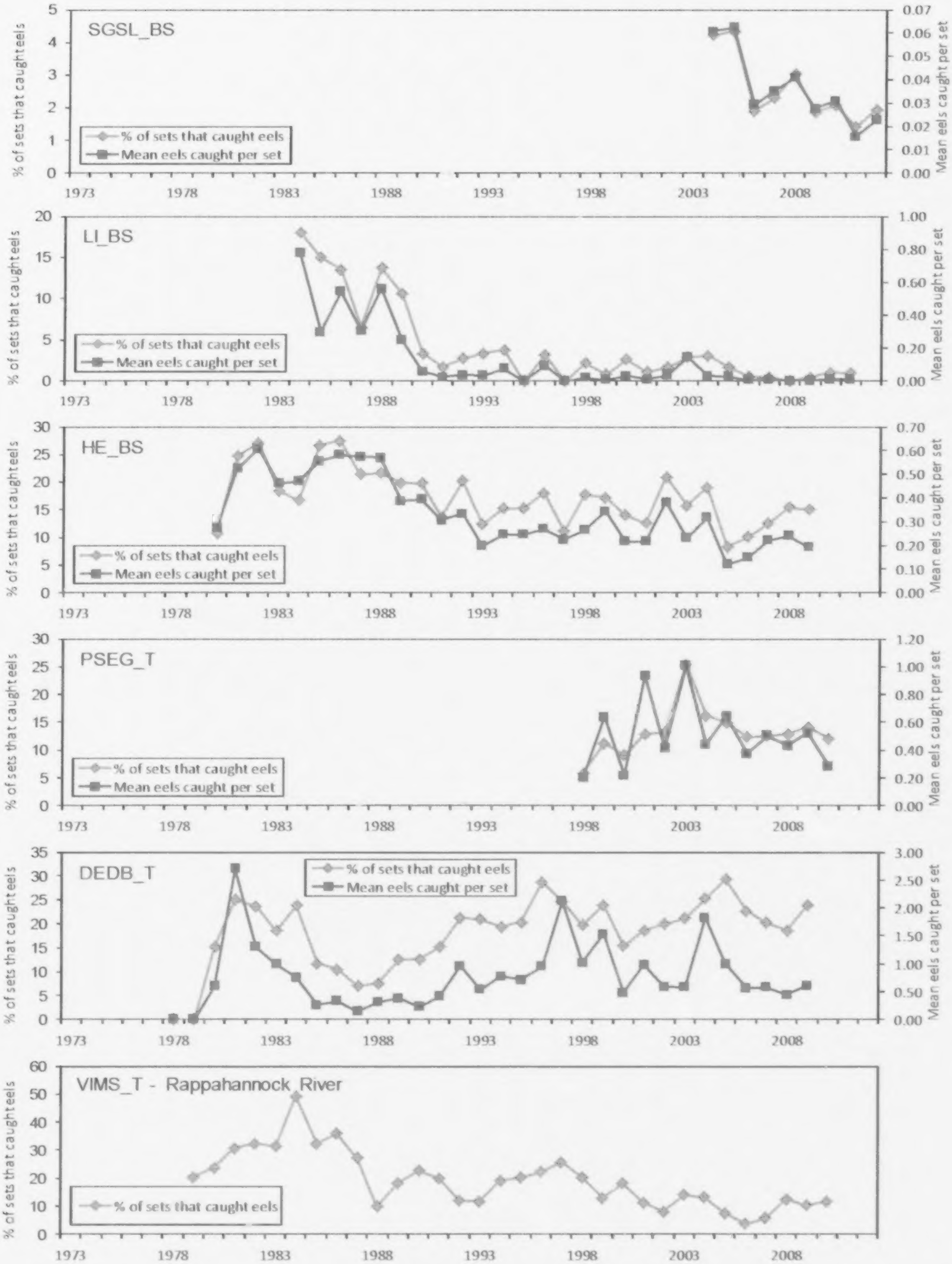


Fig. 32. Catch rate of eels by year, in SGLS_BS, LI_BS, HE_BS, PSEG_T, DEDB_T, three tributaries on the west side of Chesapeake Bay (VIMS_T), and NCJUV_T. Mean eels caught per set is unavailable for VIMS_T.

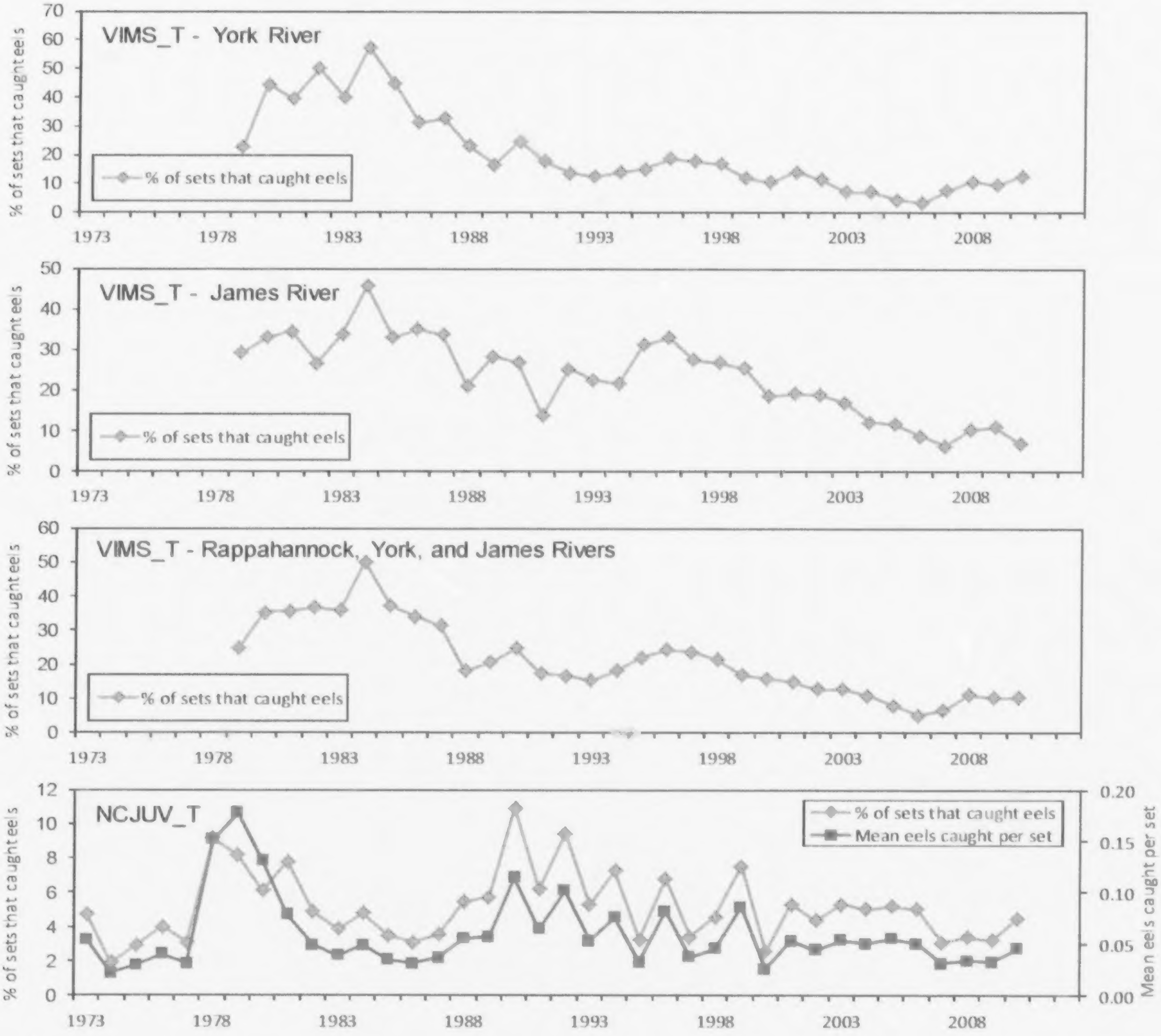


Fig. 32 (continued)

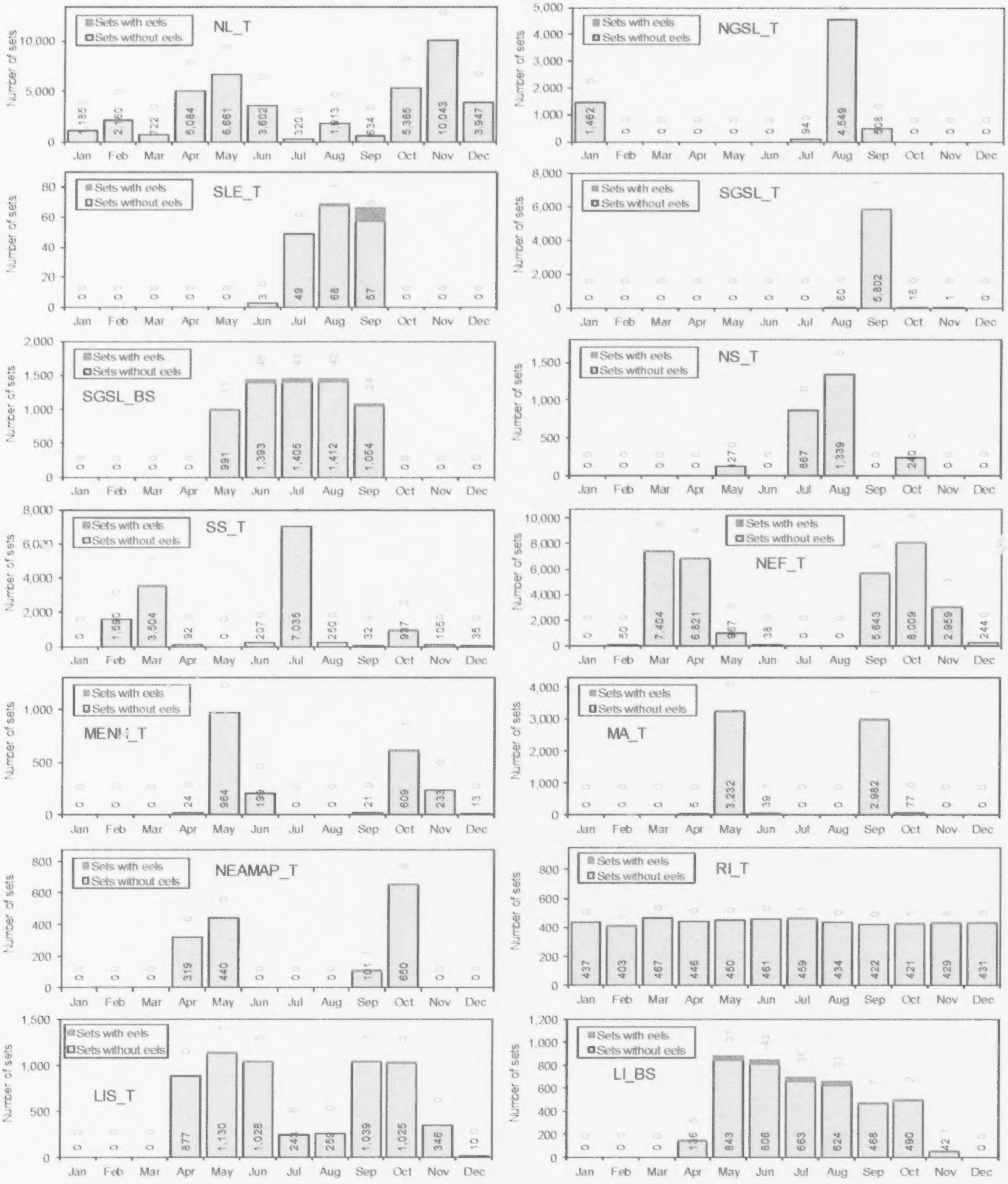


Fig. 33. Number of research survey sets by month. Numbers of sets with eels are shown in red font and numbers of sets without eels are shown in black font.

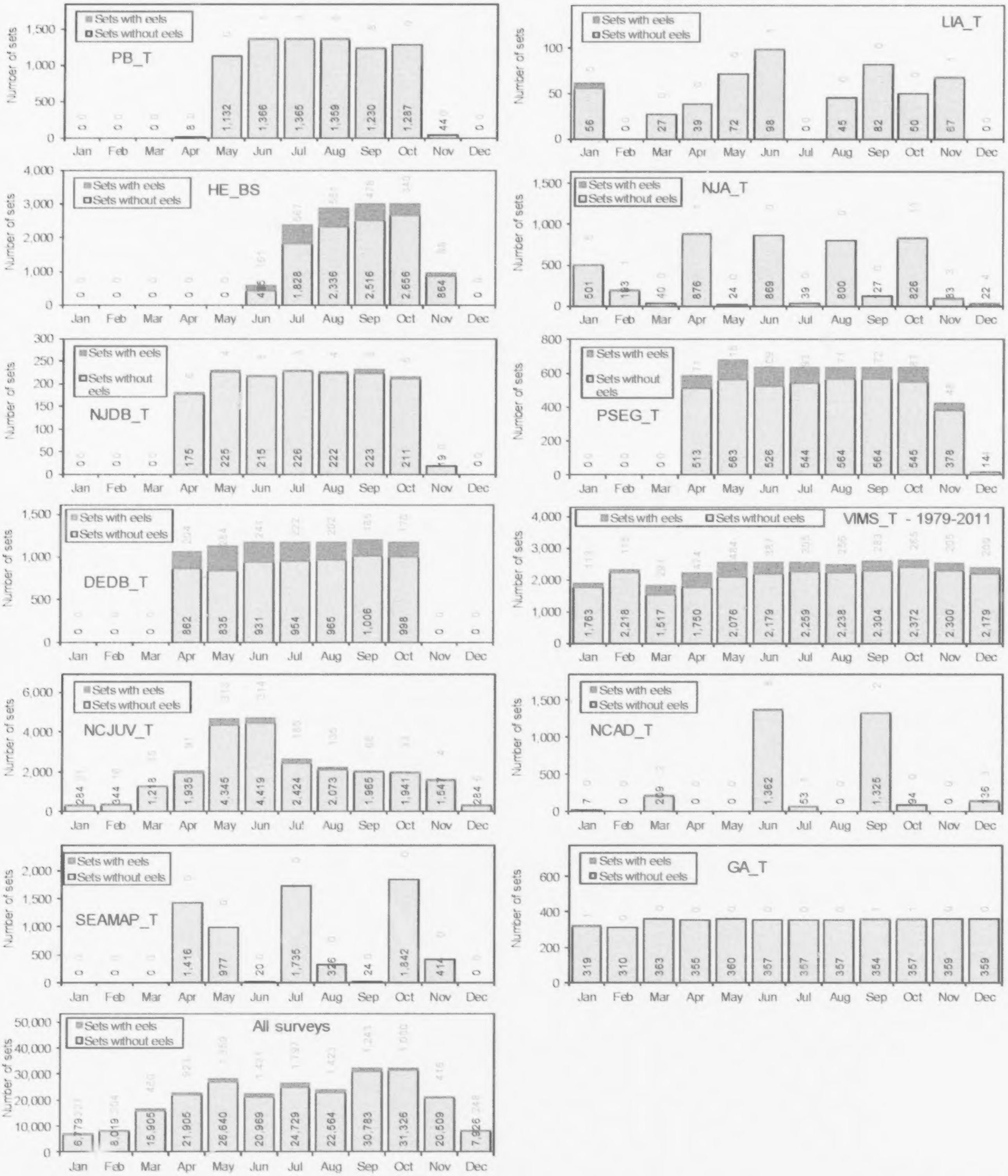


Fig.33 (continued)

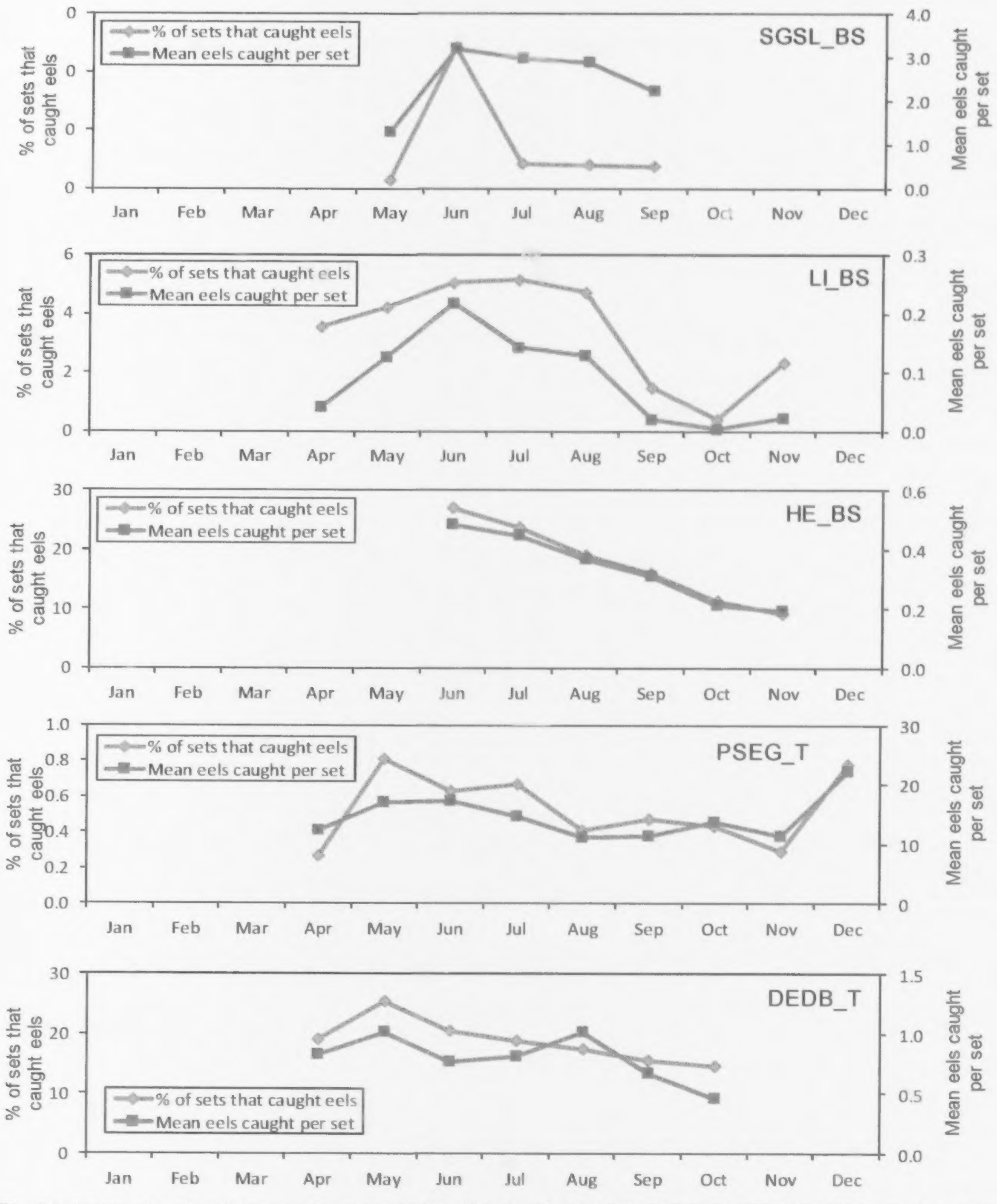


Fig. 34. Catch rate of eels by month, in the SGSL_BS, LI_BS, HE_BS, PSEG_T, DEDB_T, VIMS_T, and NCJUV_T surveys. Mean eels caught per set is unavailable for VIMS_T.

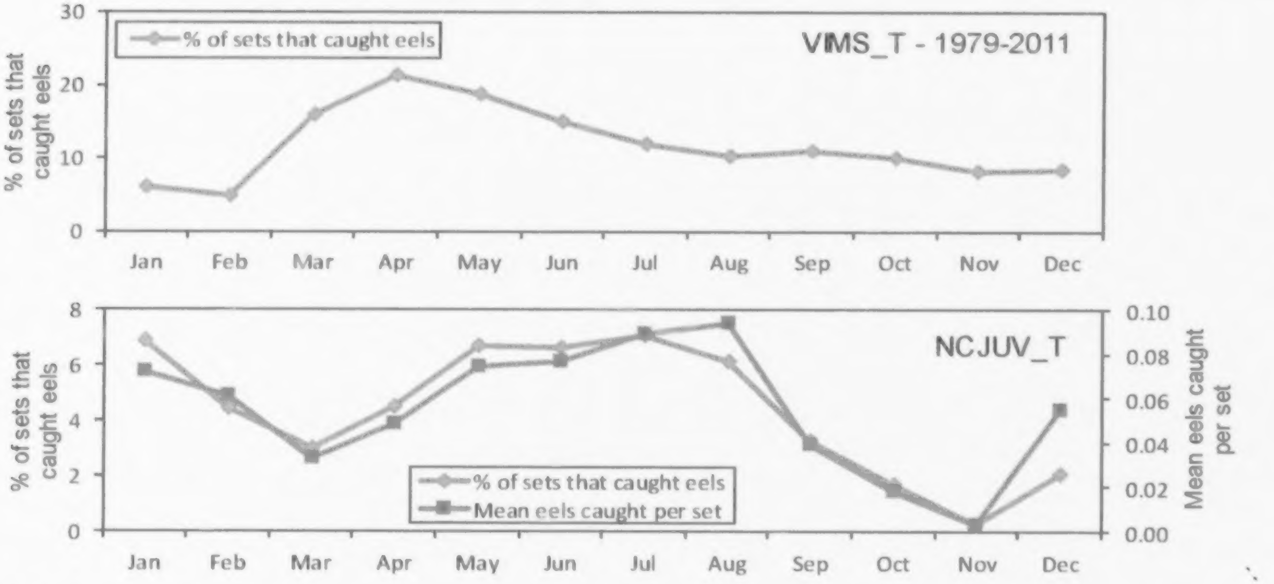


Fig. 34 (continued)

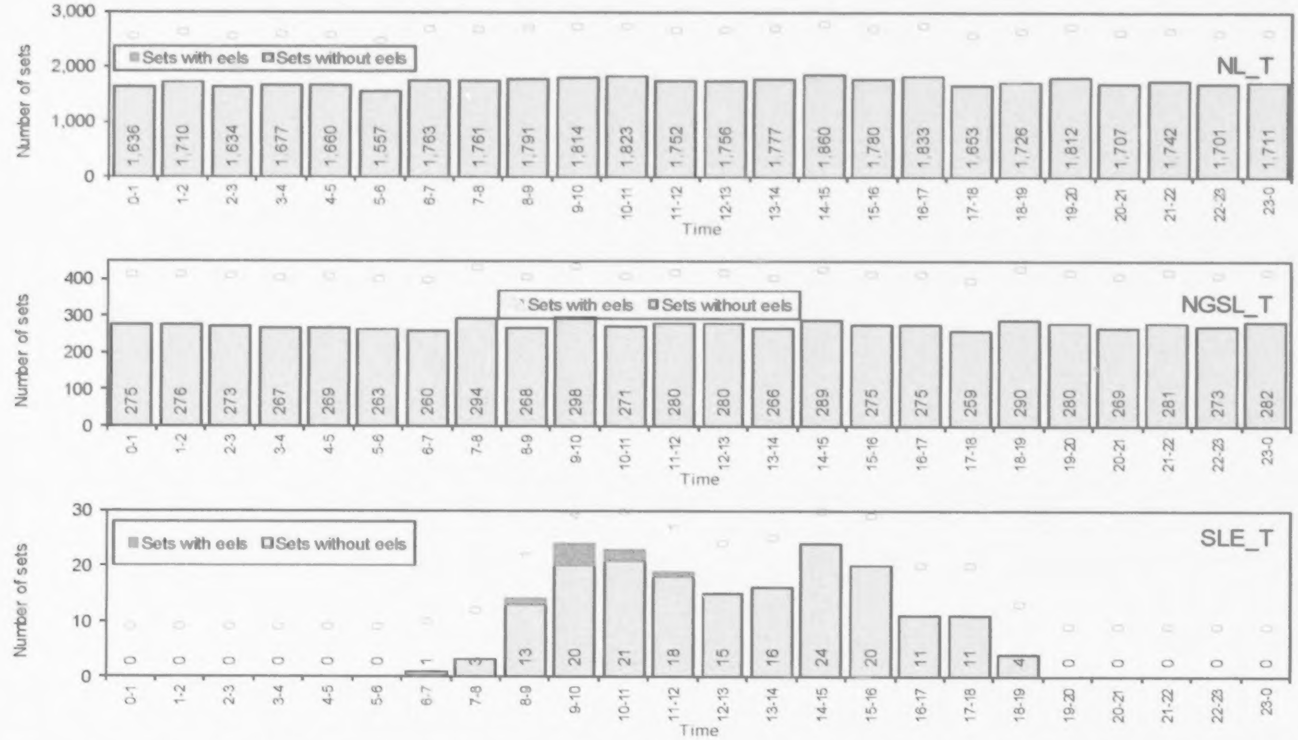


Fig. 35. Number of research survey sets by time, in NL_T, NGSL_T, SLE-T, SGSL_T, NS_T, SS_T, NEF_T, MENH_T, MA_T, NEAMAP_T, RI_T, LIA_T, HEB_BS, NJAT_T, PSEG_T, NCAD_T, SEAMAP_T, GA_T, and all surveys. The all surveys panel gives data only for surveys in which hour of the day was recorded. Numbers of sets with eels are shown in red font and numbers of sets without eels are shown in black font.

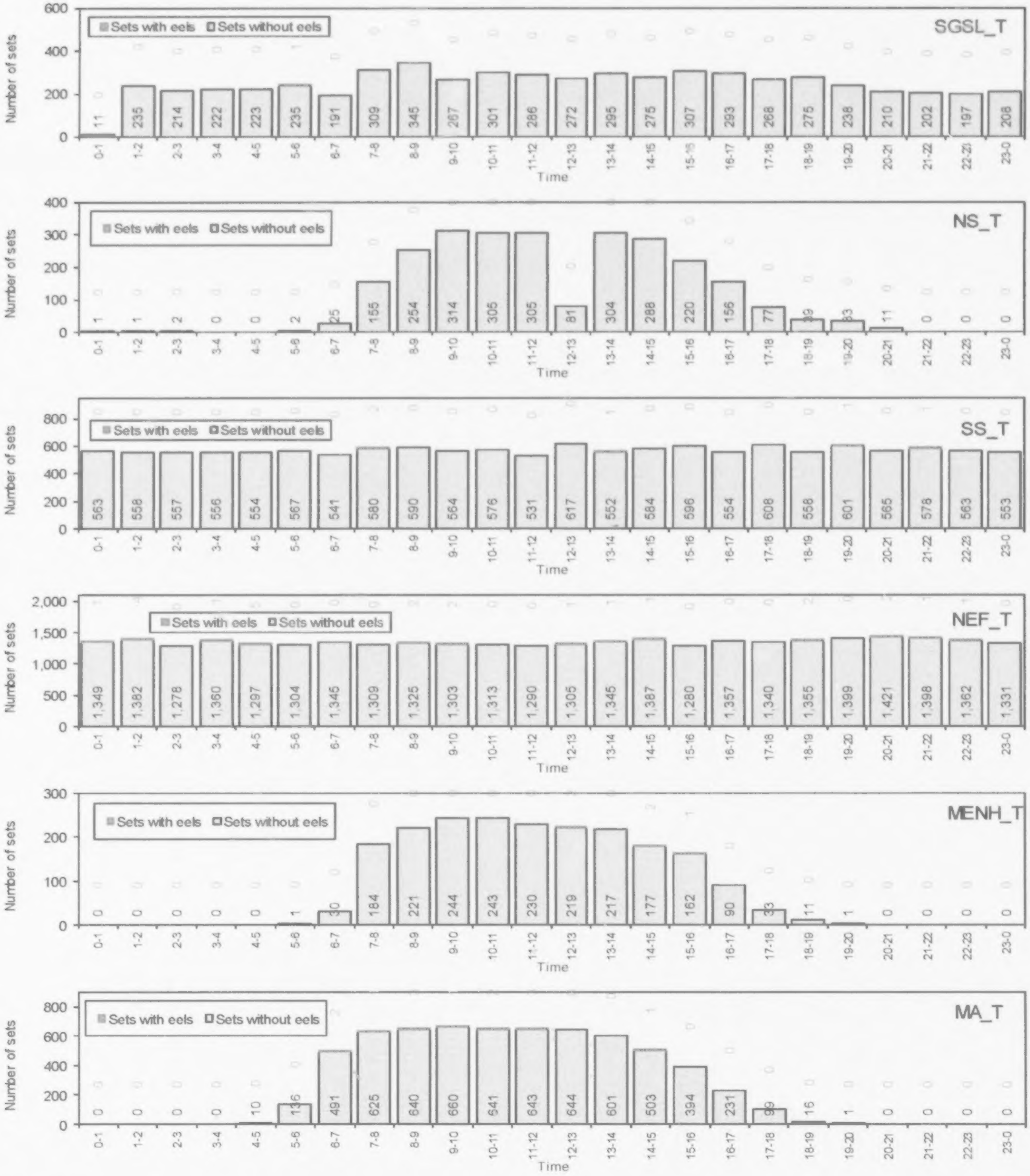


Fig. 35 (continued)

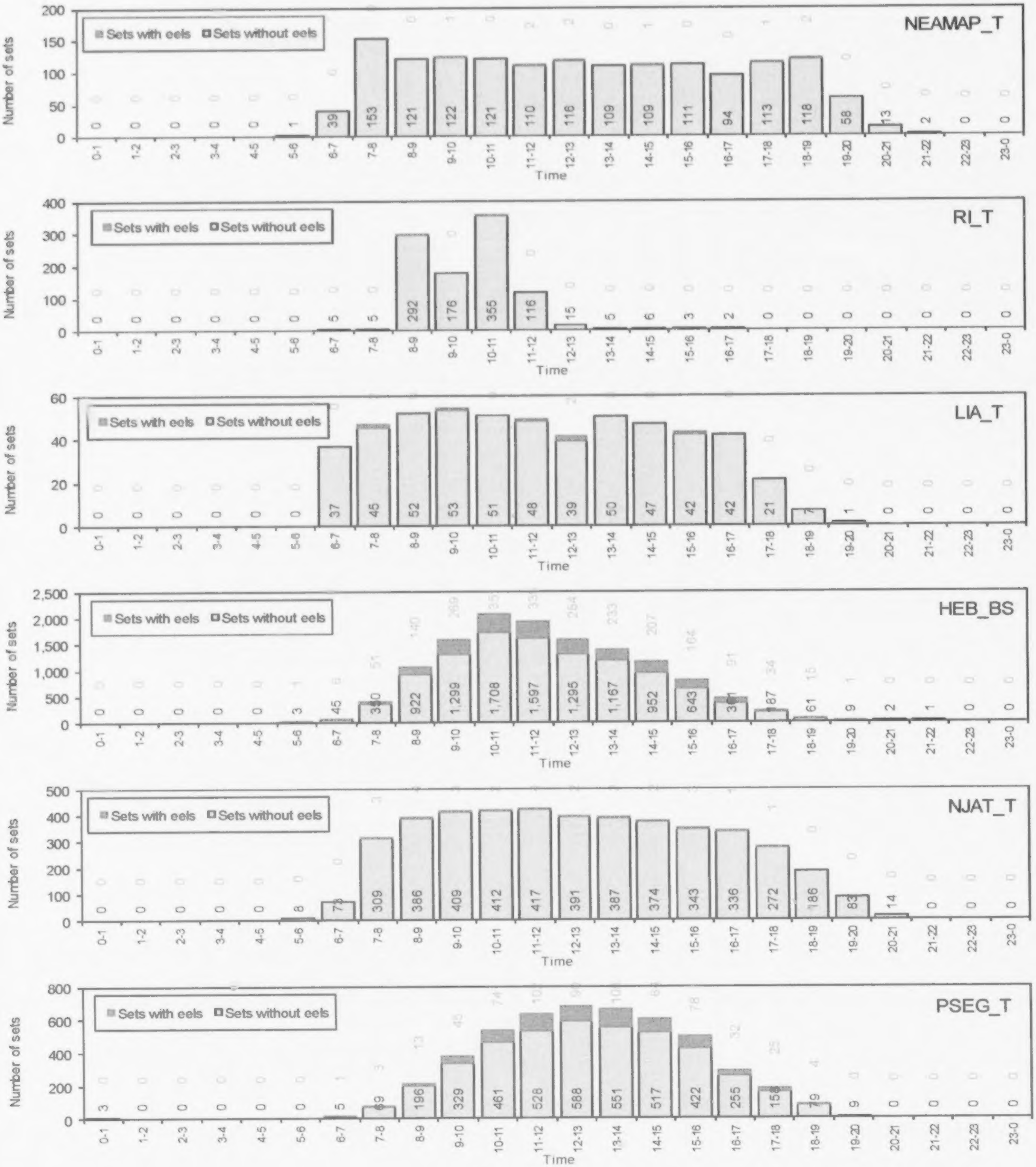


Fig. 35 (continued)

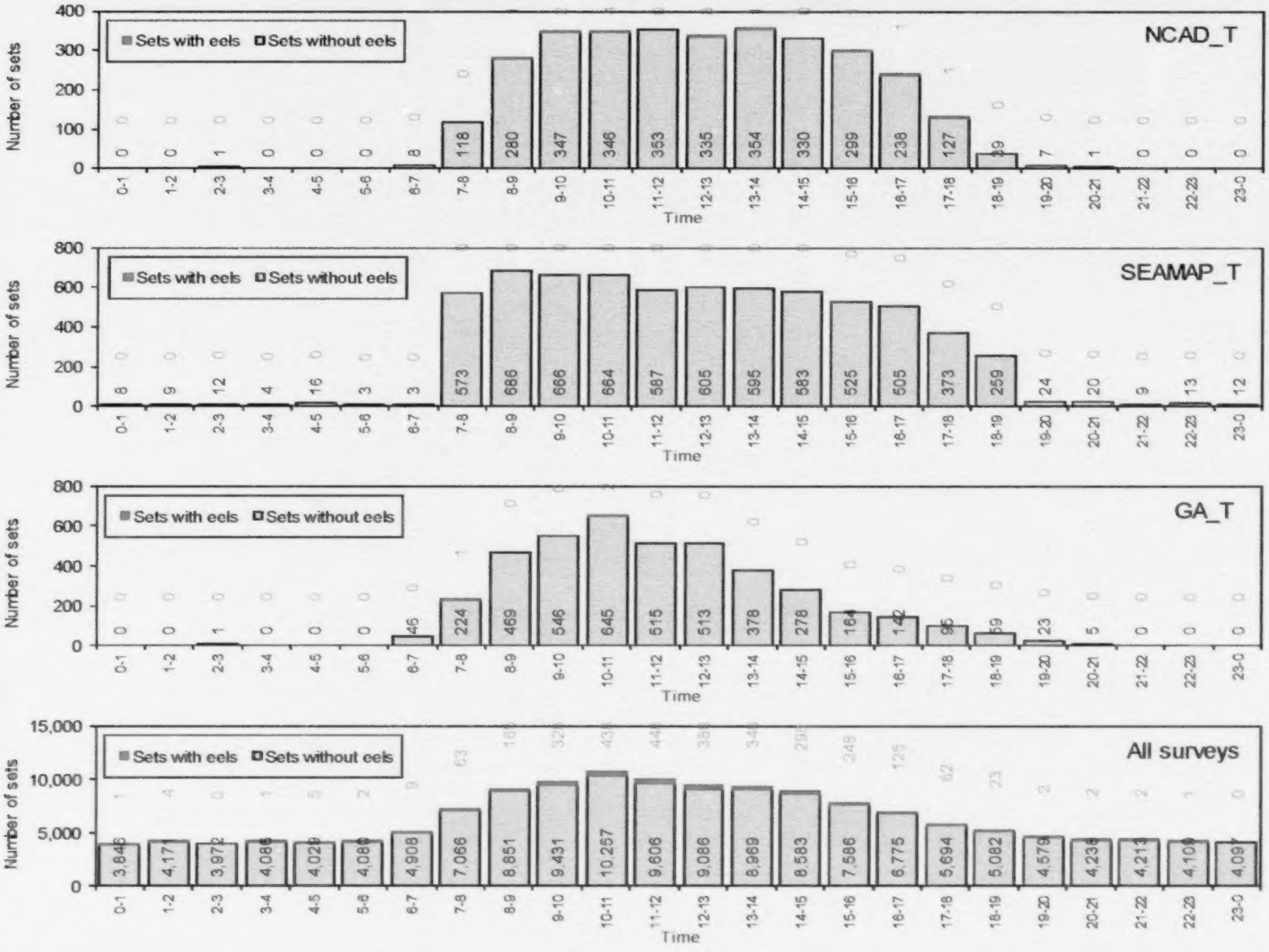


Fig. 35 (continued)

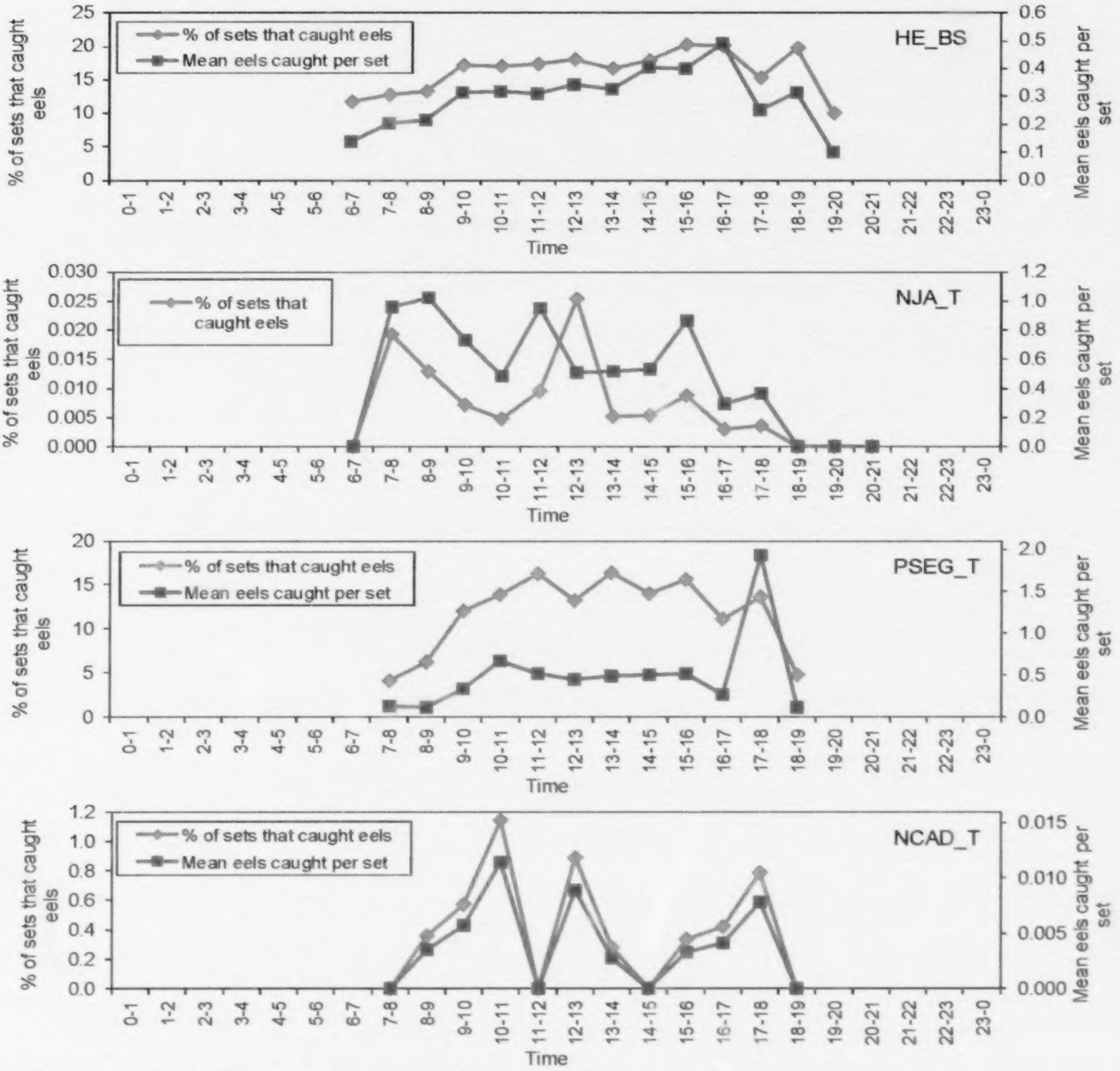


Fig. 36. Catch rate of eels by time of the day, in the HE_BS, NJA_T, PSEG_T, and NCAD_T surveys.

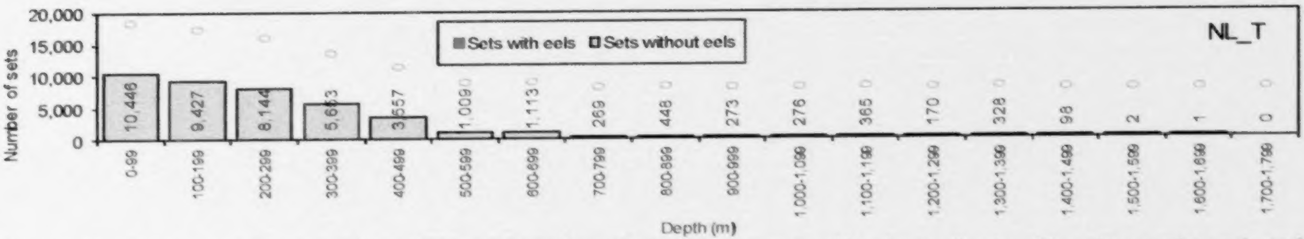


Fig. 37. Number of survey sets by depth, by 100 m bins, in the NL_T survey. Numbers of sets with eels are shown in red font and number of sets without eels are shown in black font.

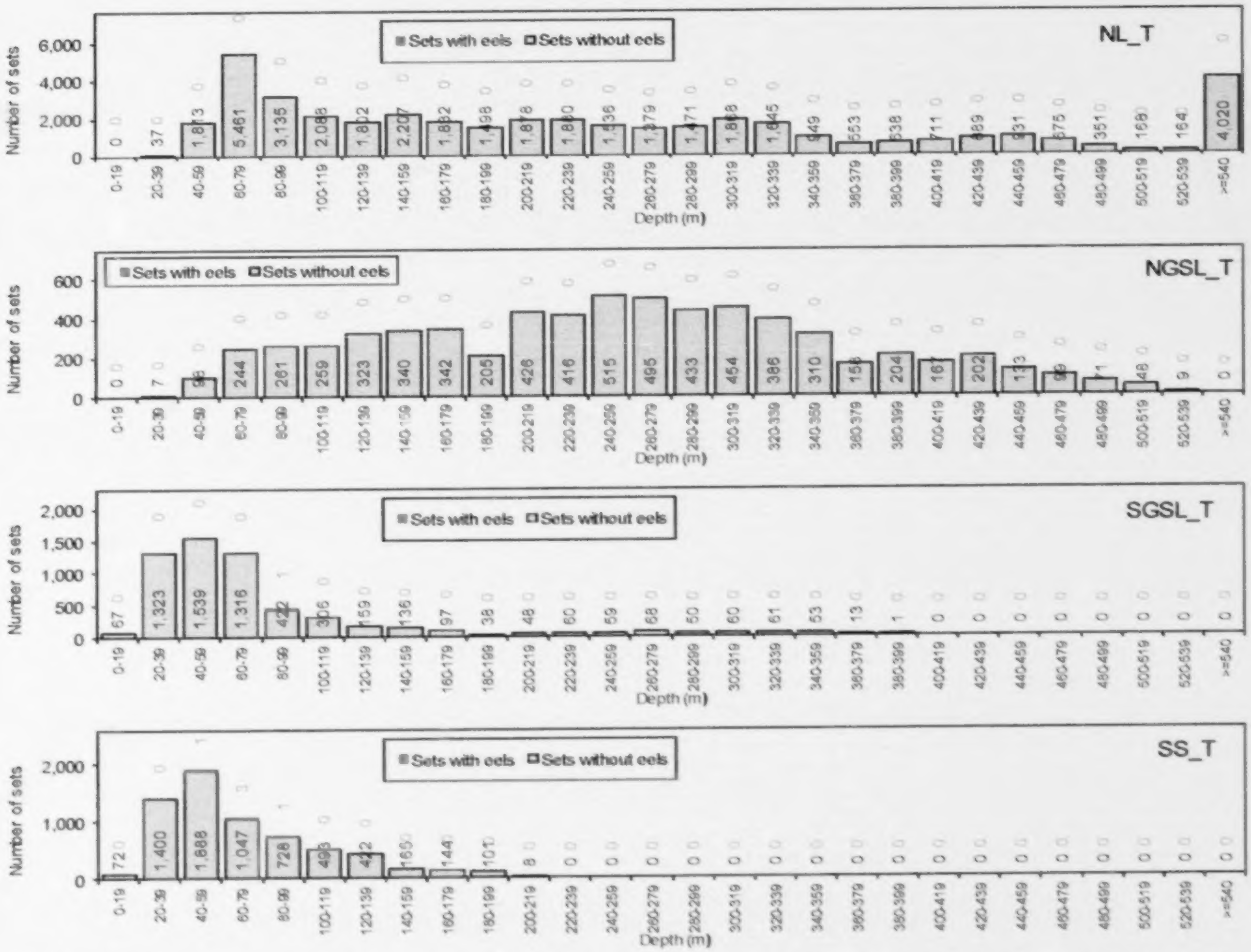


Fig. 38. Number of trawl survey sets by depth, by 20 m bins, in surveys whose maximum site depth exceeds 70 m. Numbers of sets with eels are shown in red font and numbers of sets without eels are shown in black font.

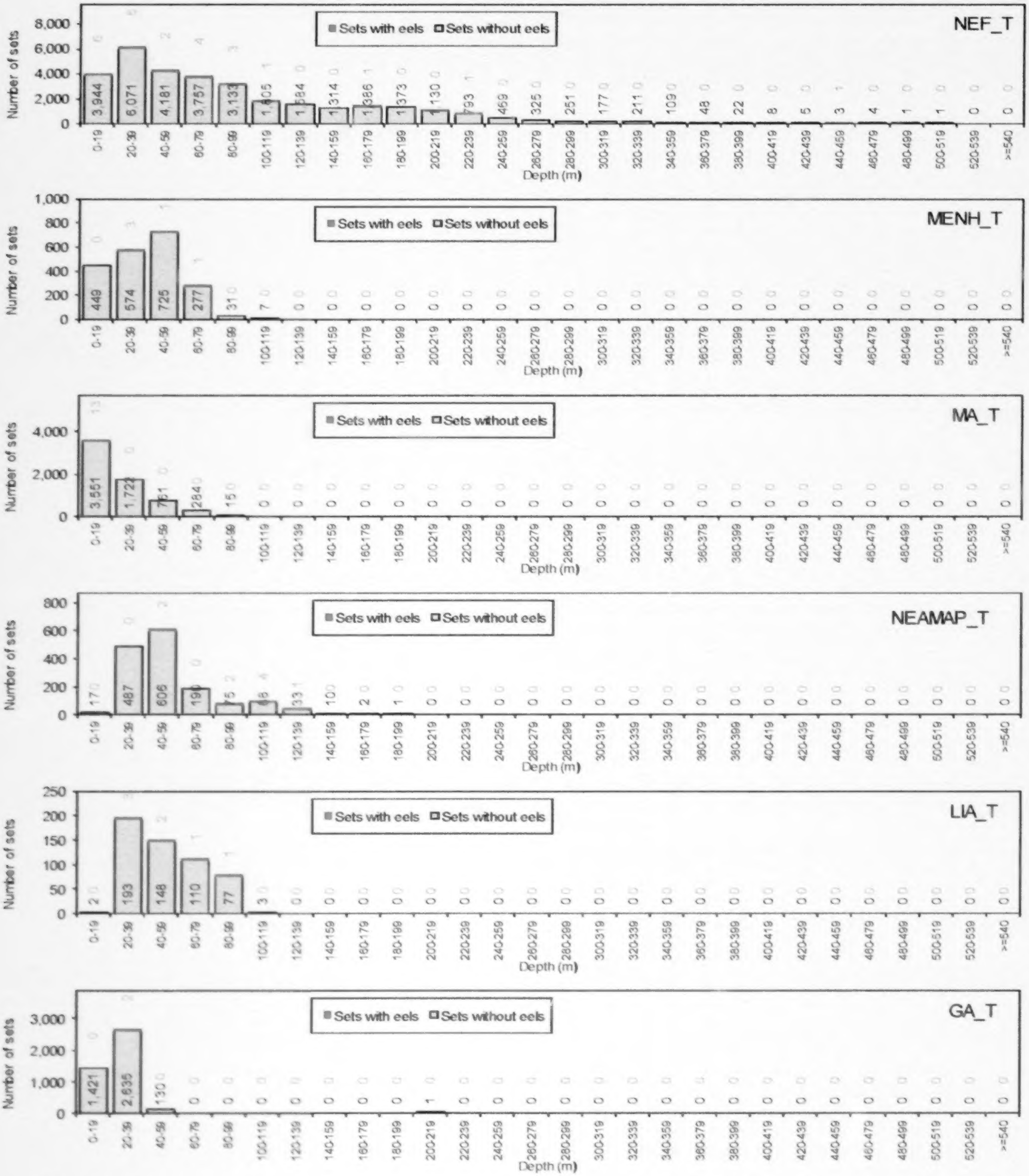


Fig. 38 (continued)

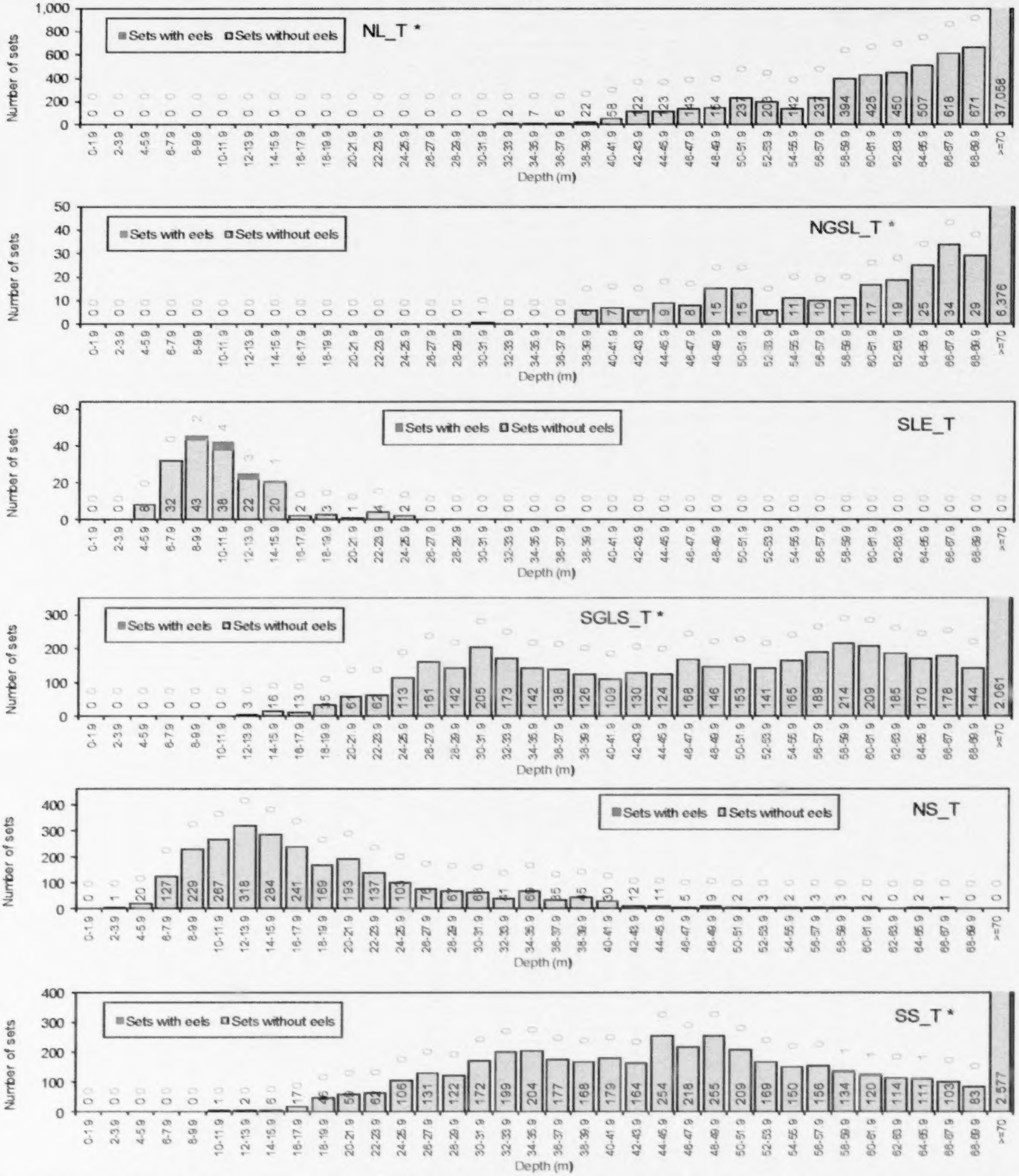


Fig. 39. Number of research survey sets by depth, by 2 m bins, to 70 m depth. An asterisk next to the survey name indicates that the number of sets in waters >70 m exceeds the vertical axis of the graph. Numbers of sets with eels are shown in red font and numbers of sets without eels are shown in black font. Major Chesapeake tributaries are the Potomac, the Rappahannock, the York, and the James Rivers.

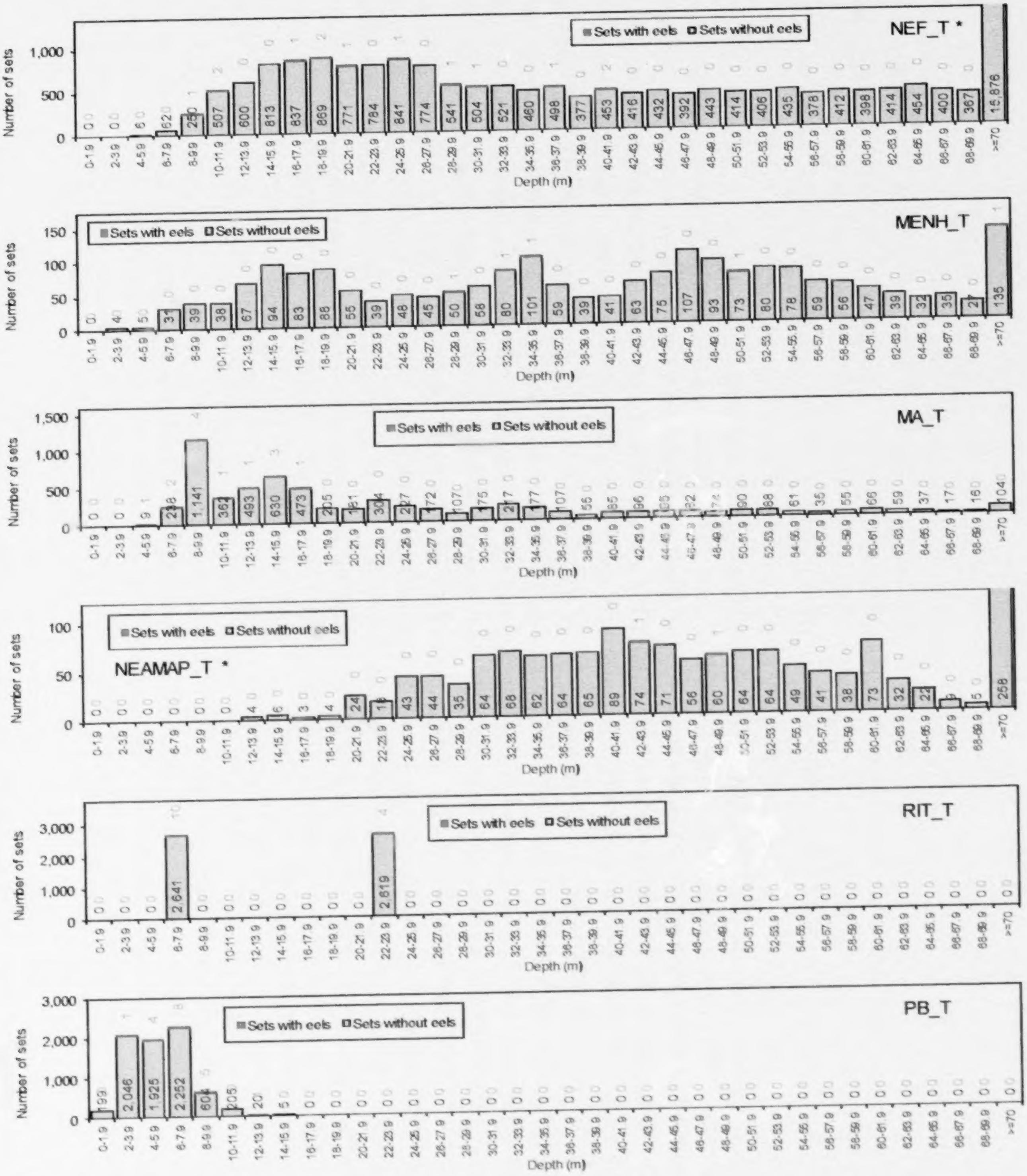


Fig. 39 (continued)

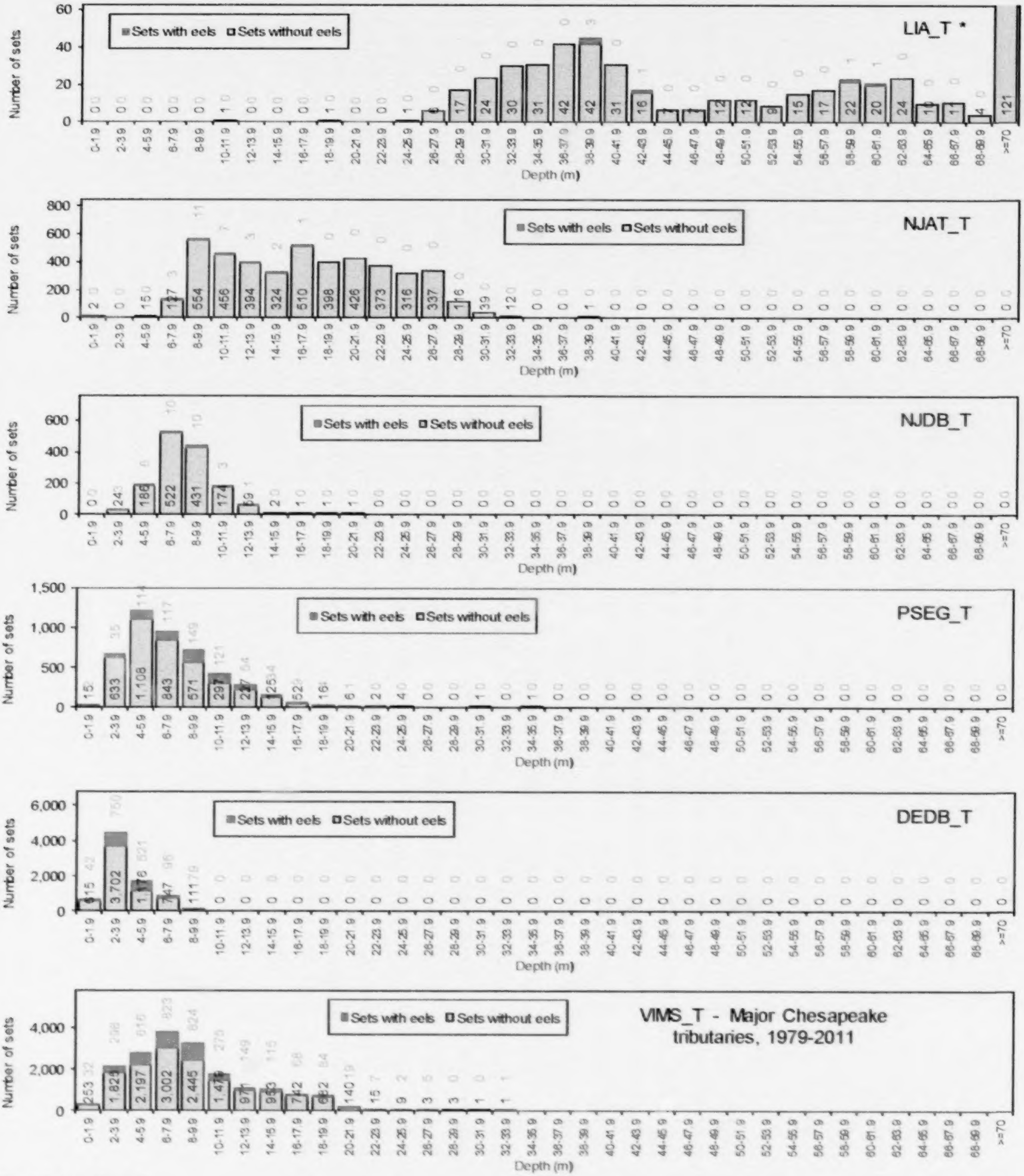


Fig. 39 (continued)

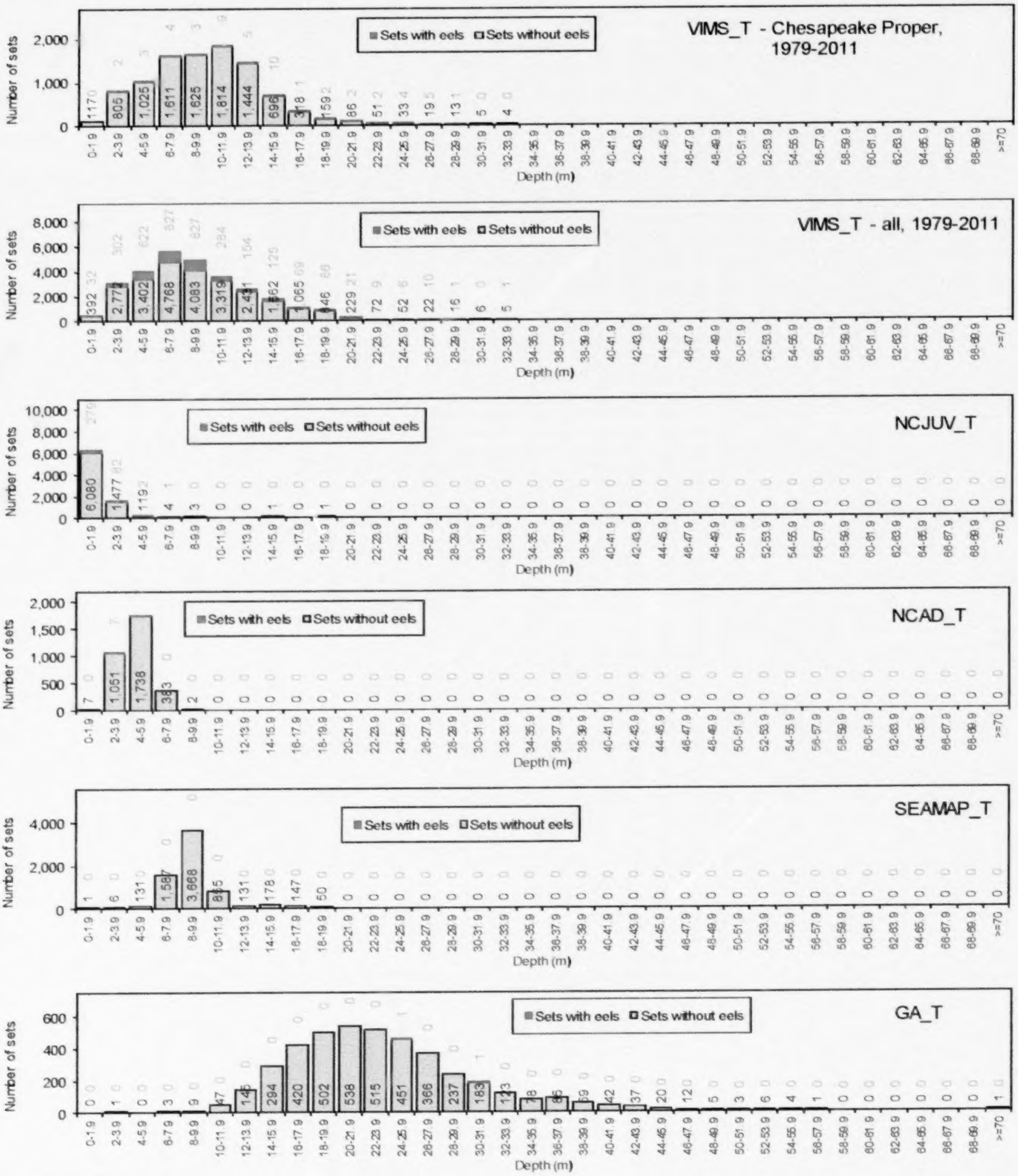


Fig. 39 (continued)

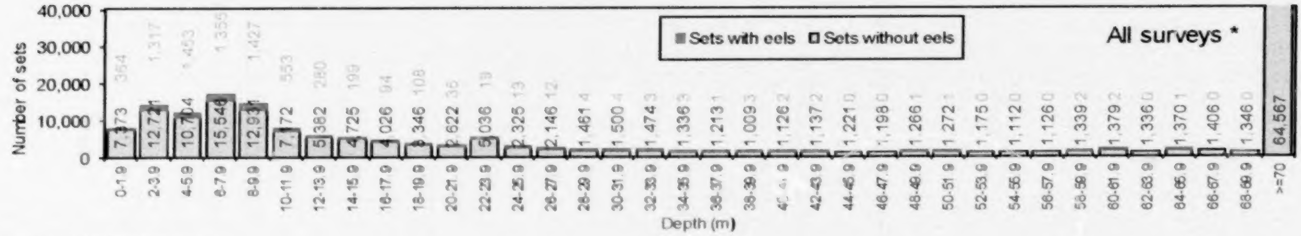


Fig. 39 (continued)

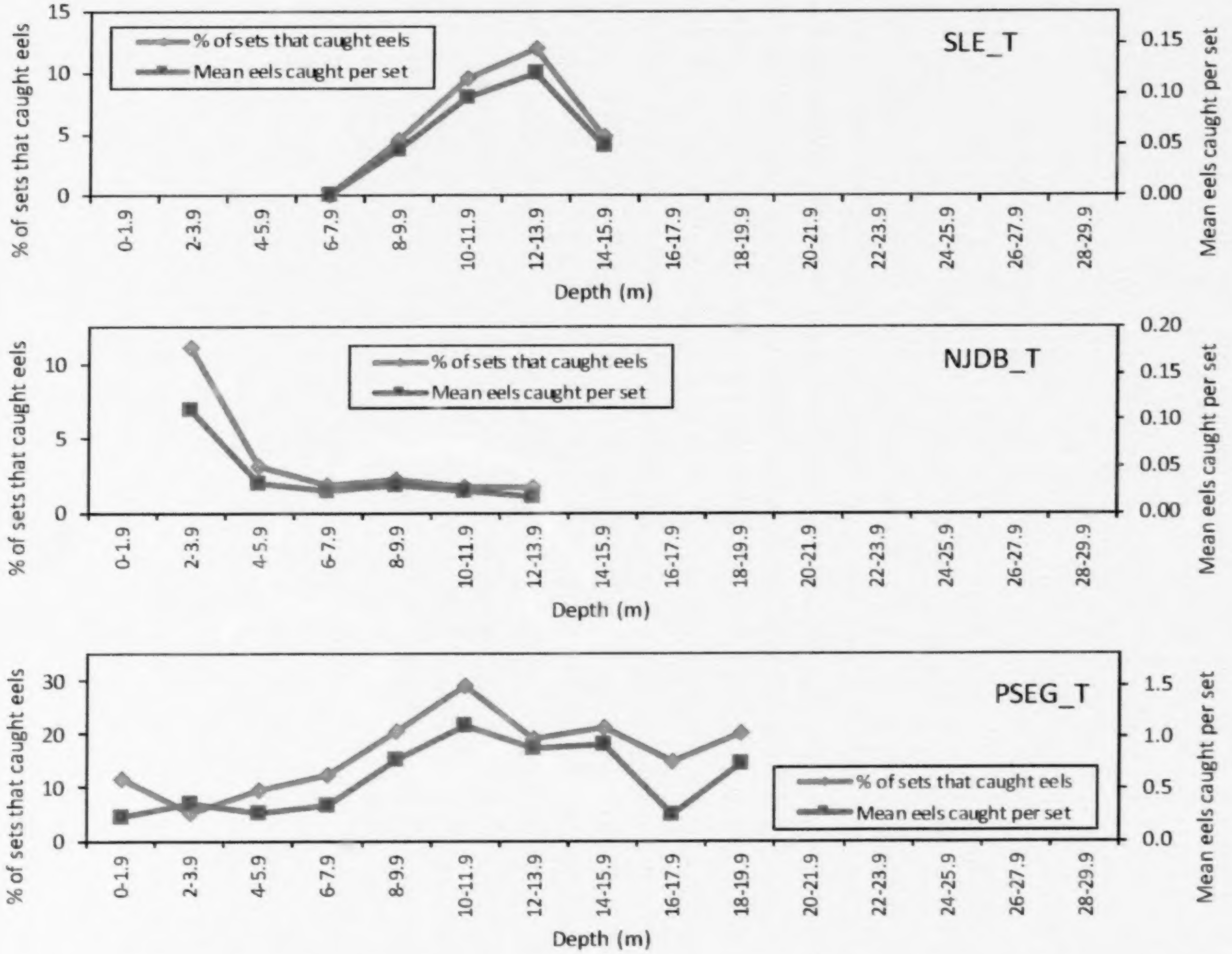


Fig. 40. Catch rates of eels by 2 m depth bins, in SLE_T, NJDB_T, DEDB_T, in major Chesapeake tributaries (Potomac, Rappahannock, York, James), in Chesapeake Bay Proper, in the full VIMS_T dataset, and in NCJUV_T. Mean eels caught per set is unavailable for VIMS_T data.

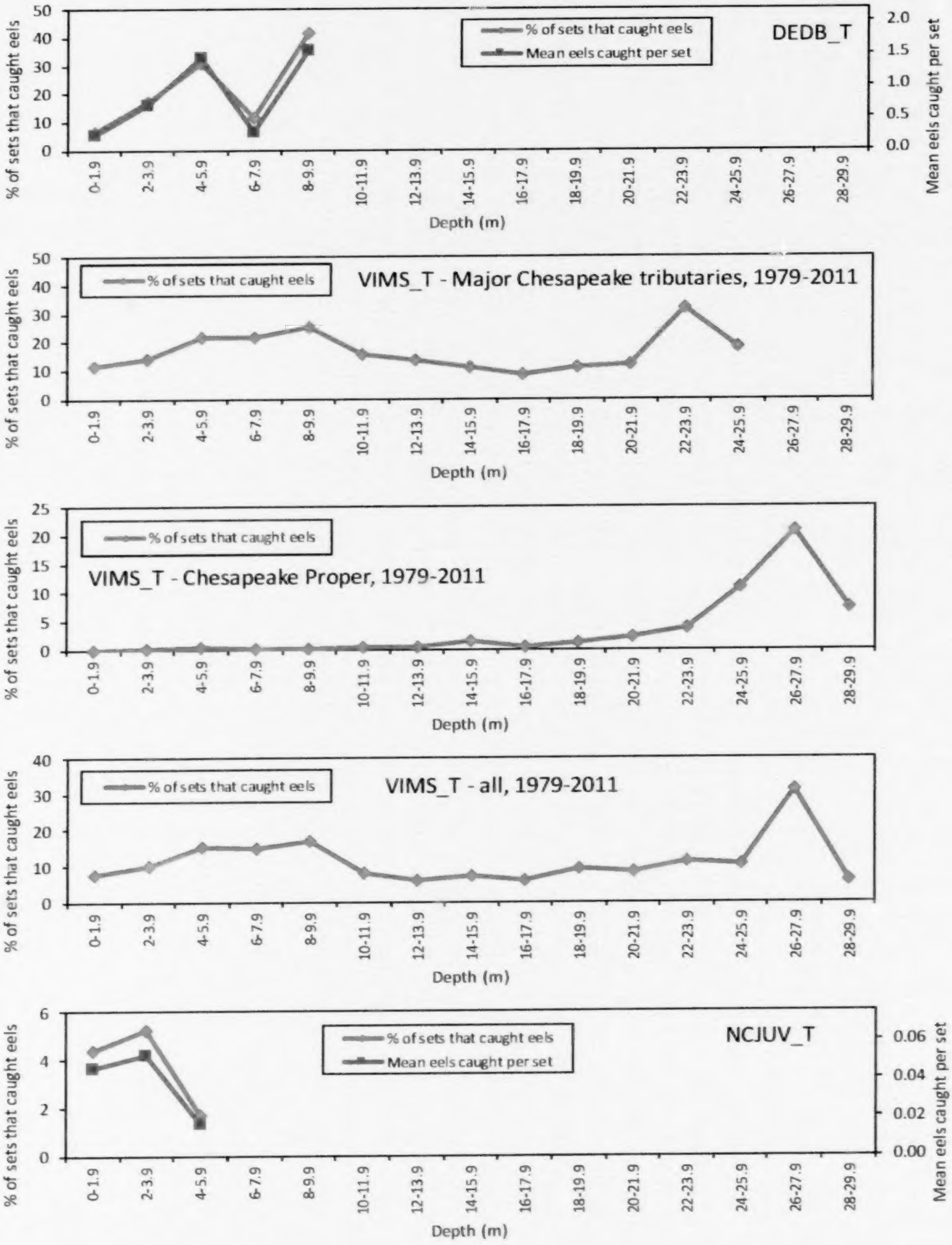


Fig. 40 (continued)

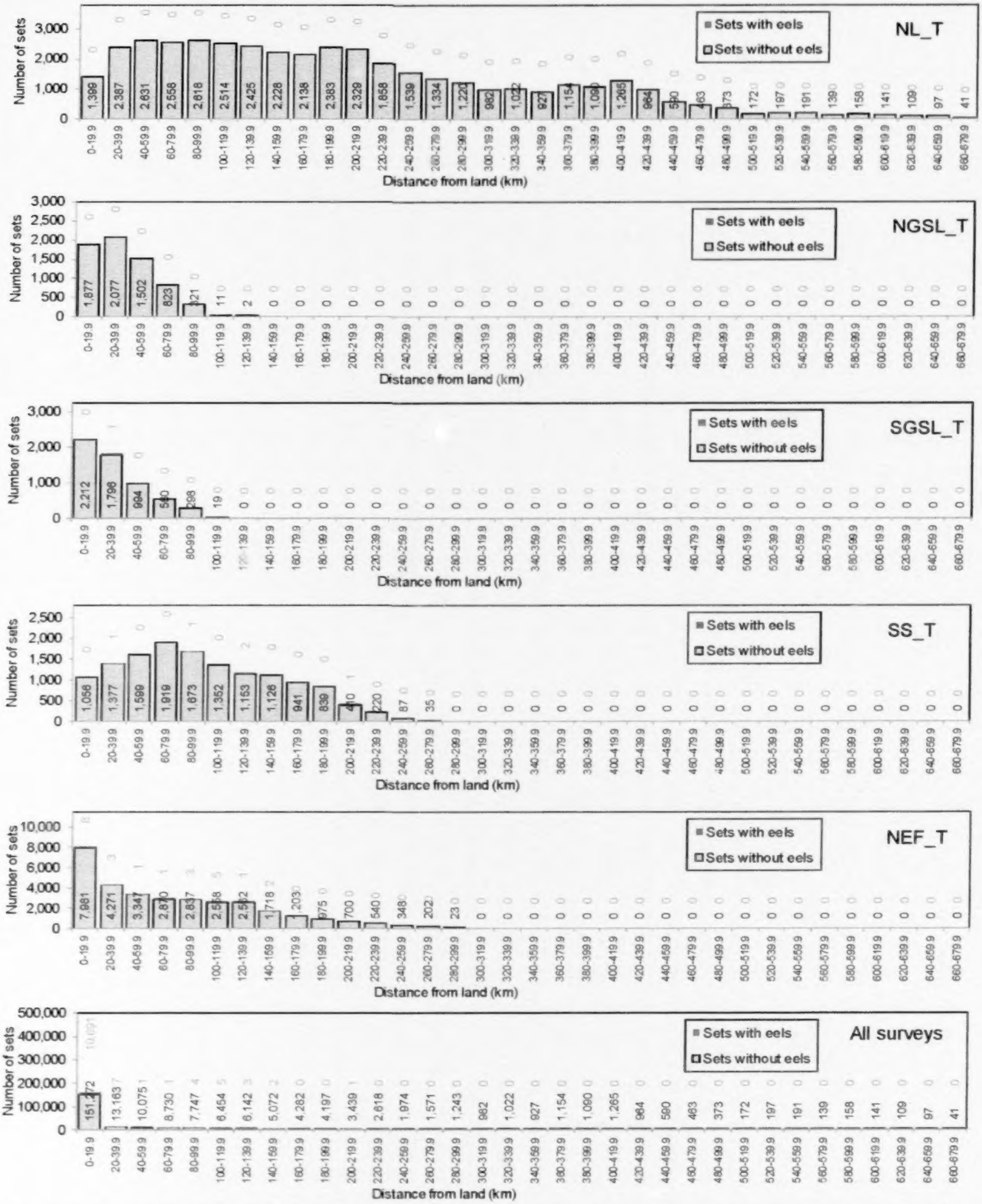


Fig. 41. Number of research survey sets by distance from land, by 20 km bins, in surveys whose maximum distance from land exceeds 50 km. Numbers of sets with eels are shown in red font and numbers of sets without eels are shown in black font.

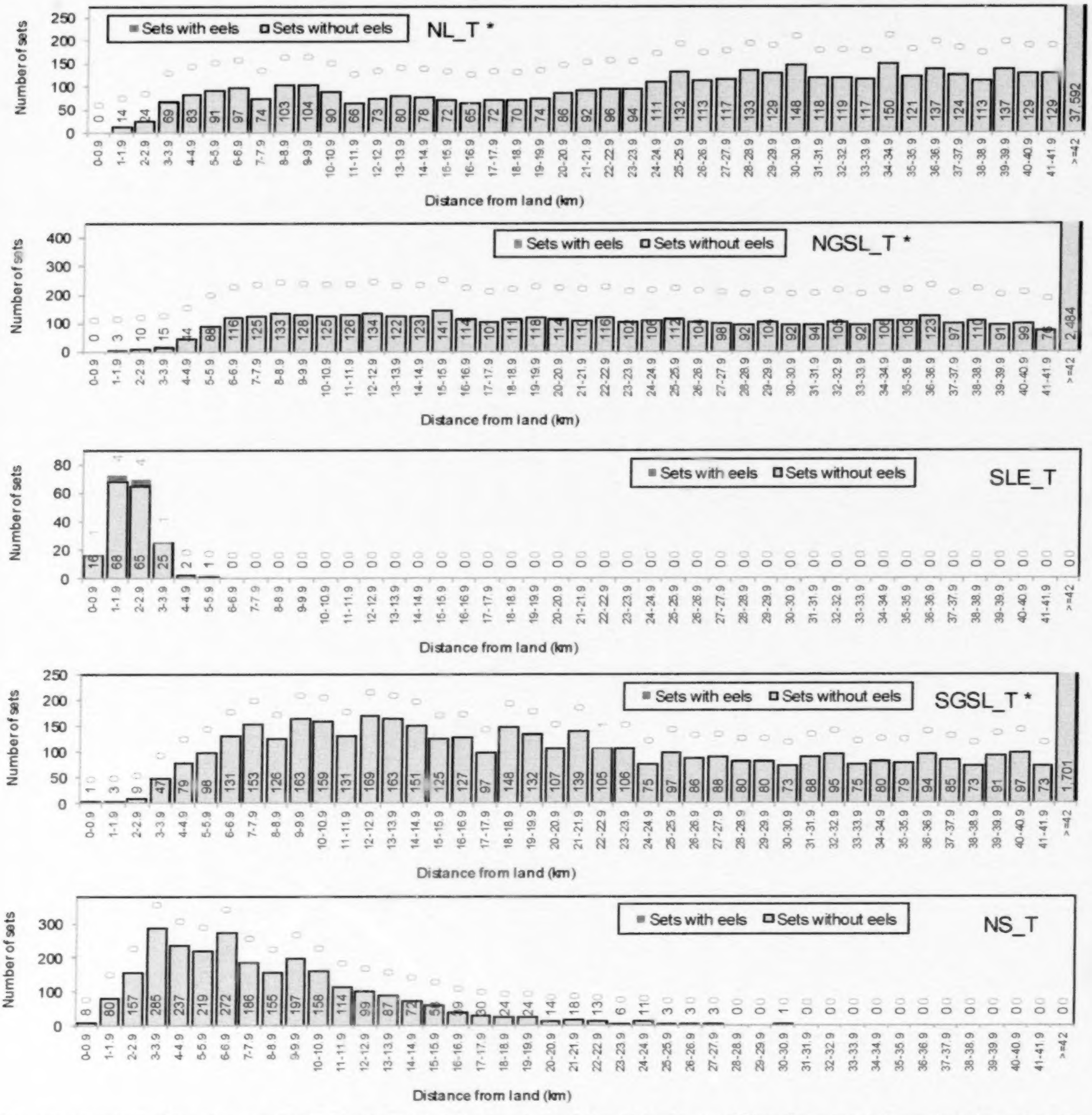


Fig. 42. Number of trawl survey sets by distance from land, by 1 km bins, up to 42 km from land. An asterisk next to the survey name indicates that the number of sets at sites >42 km from land exceeds the vertical axis of the graph. Numbers of sets with eels are shown in red font and numbers of sets without eels are shown in black font. . Major Chesapeake tributaries are the Potomac, the Rappahannock, the York, and the James Rivers.

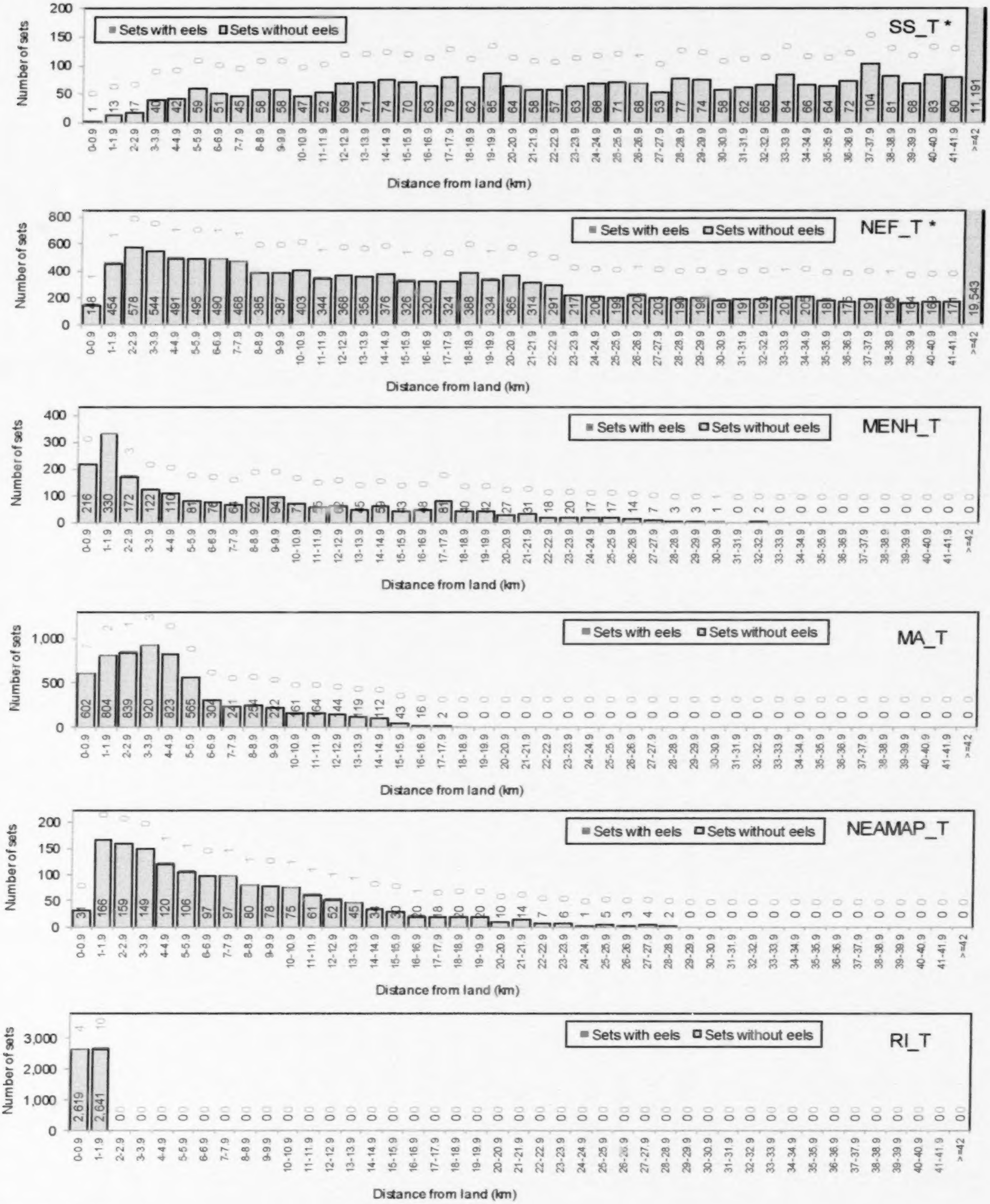
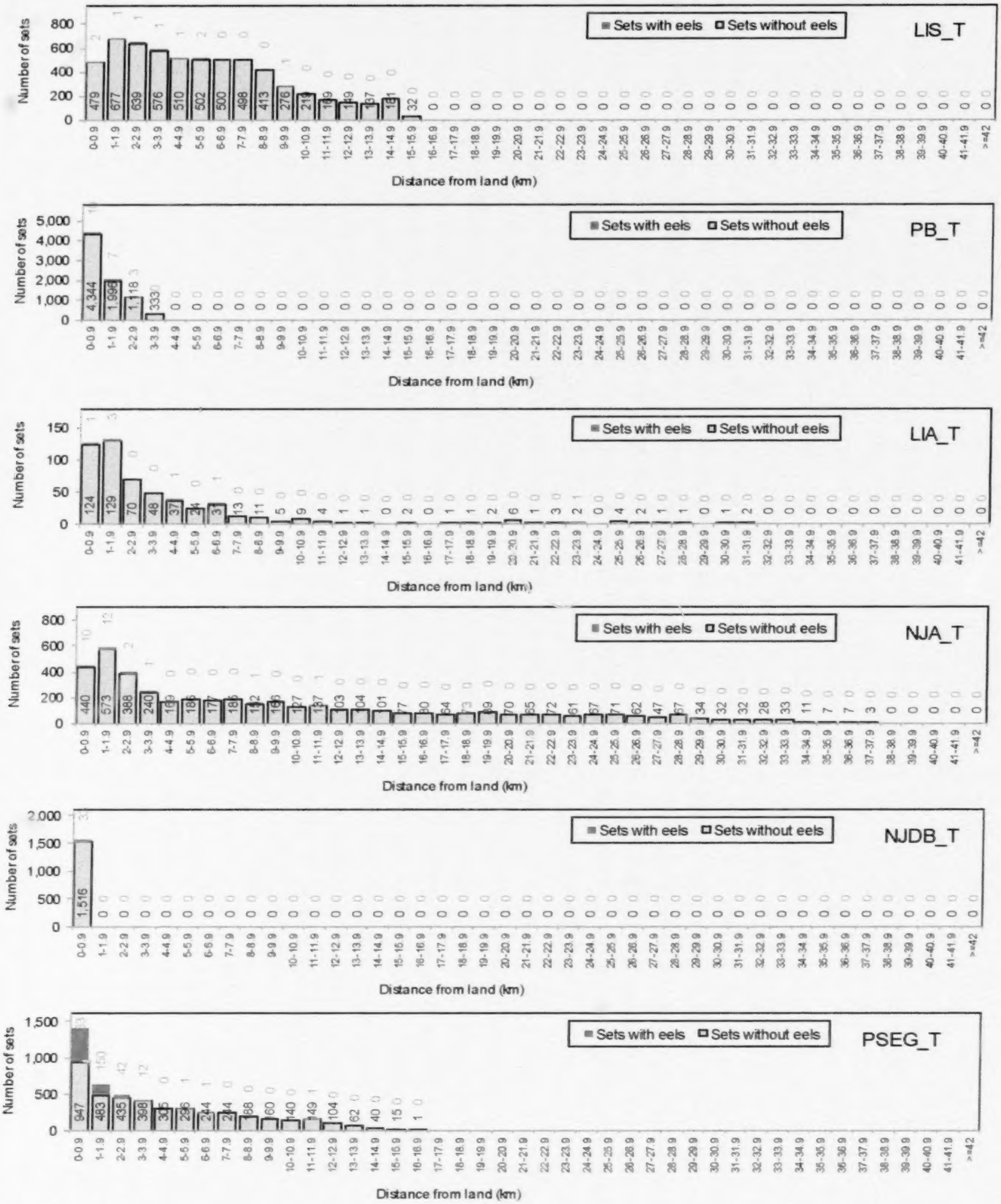


Fig. 42 (continued)



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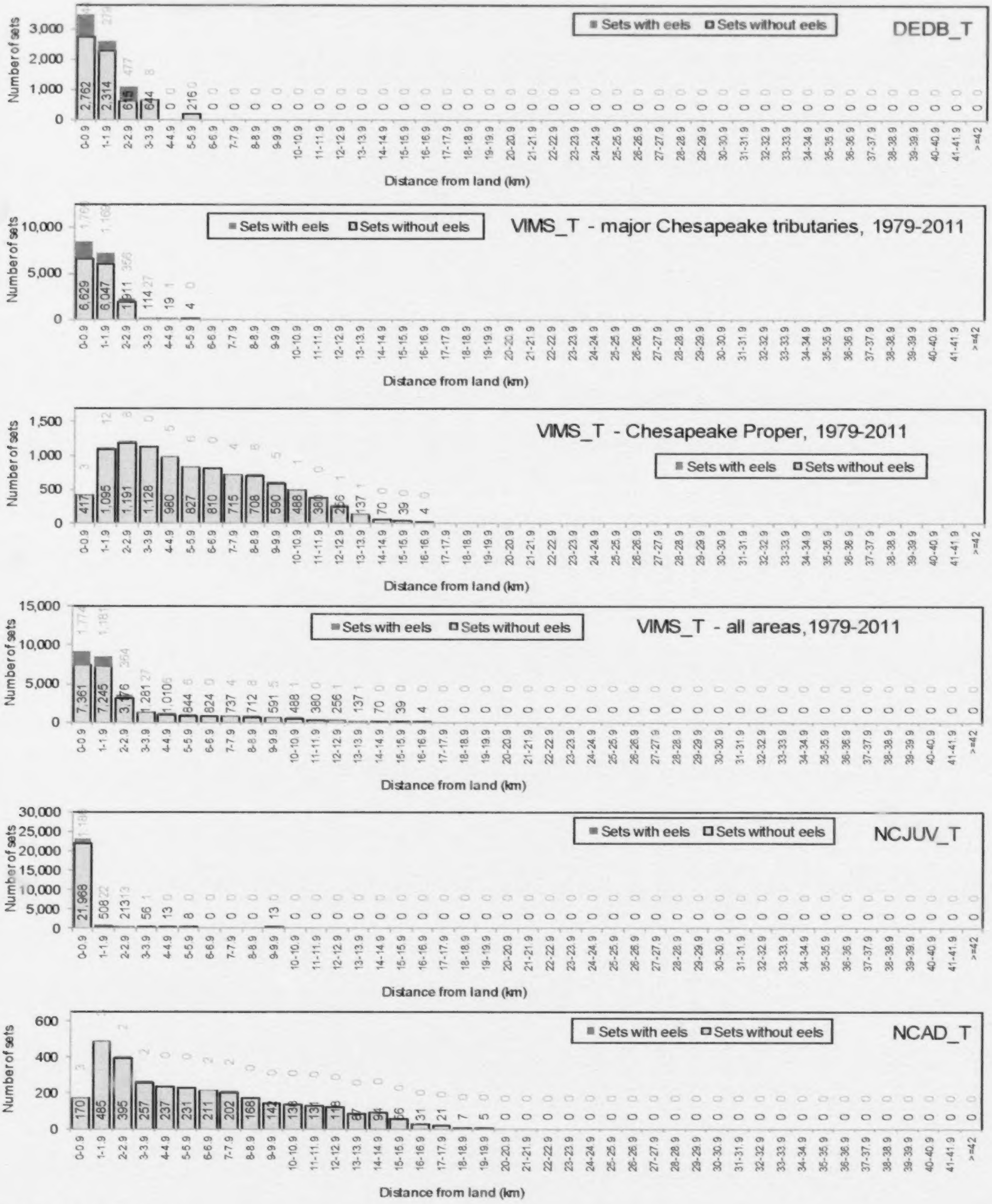

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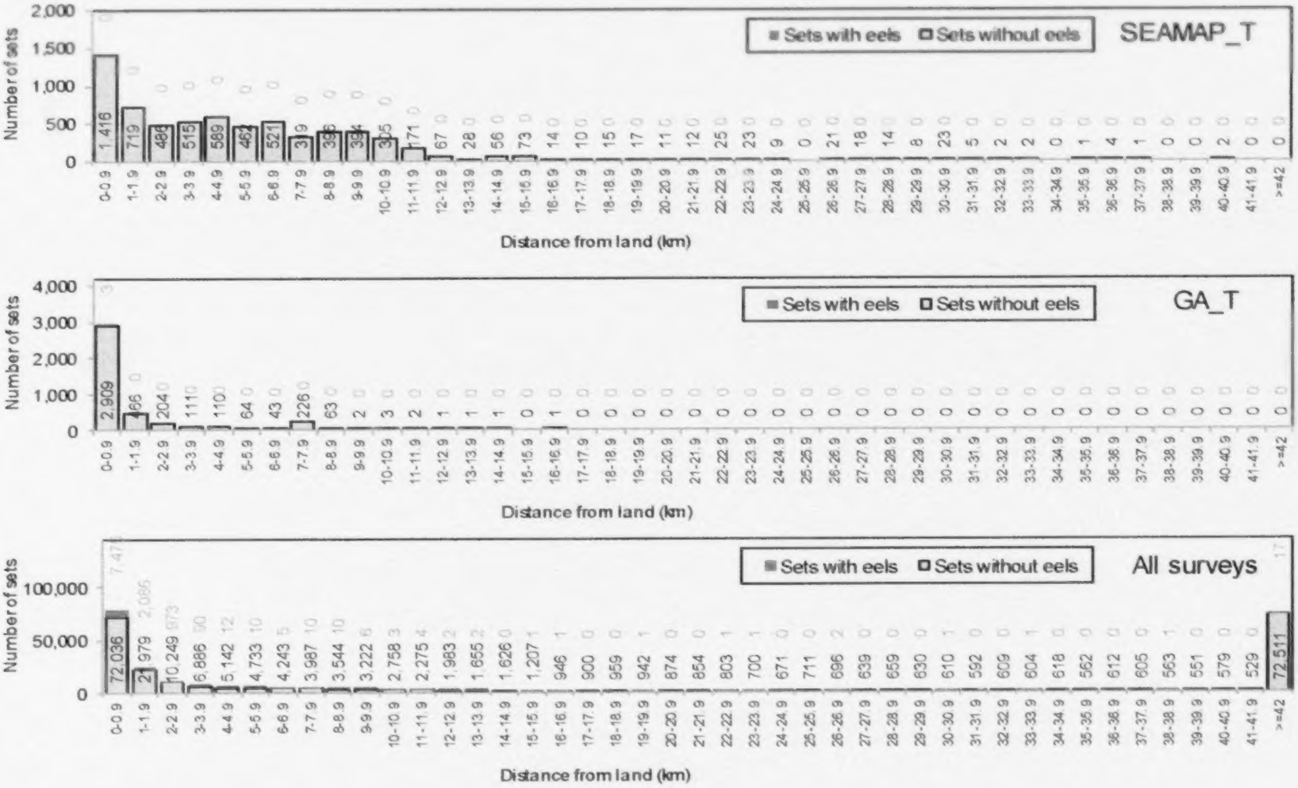


Fig. 42 (continued)

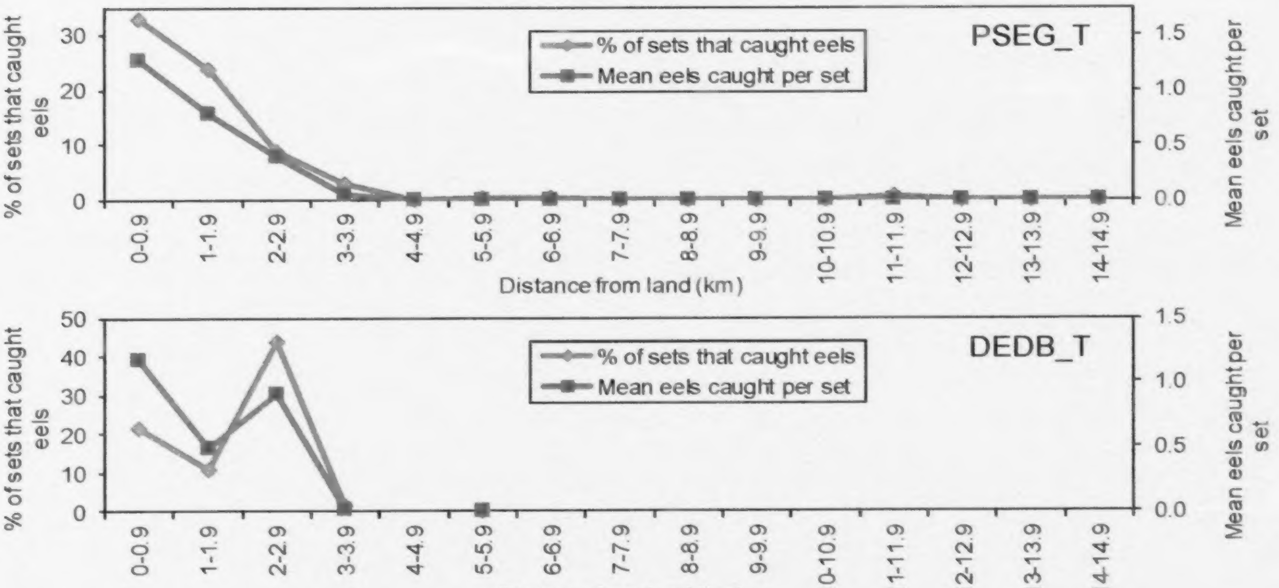


Fig. 43. Catch rate of eels by distance from land, in PSEG_T, DEDB_T, in major Chesapeake tributaries (Potomac, Rappahannock, York, James), in Chesapeake Bay Proper, in the full VIMS_T dataset, and in NCJUV_T Mean eels caught per set is unavailable for VIMS_T data.

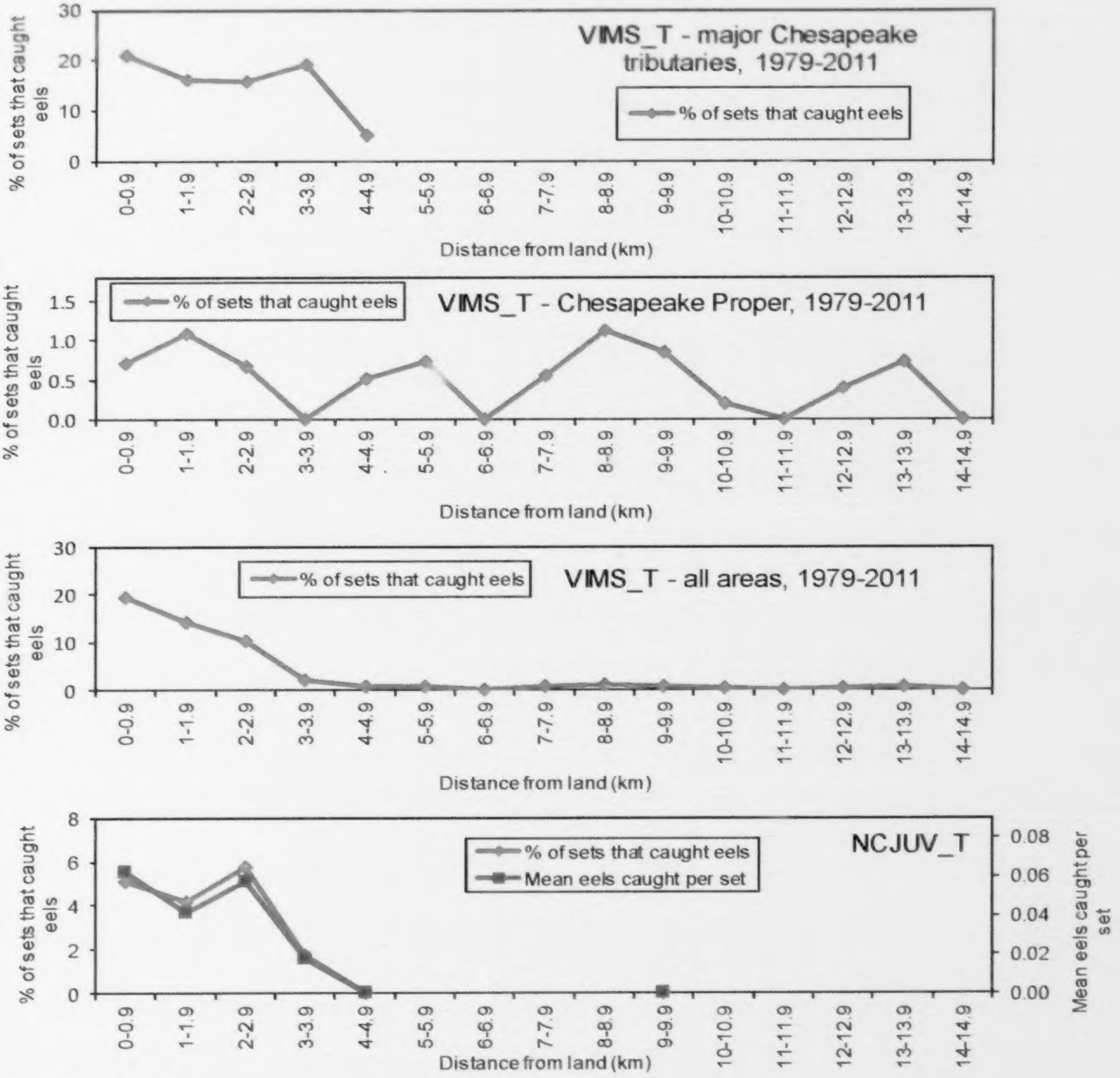


Fig. 43 (continued)

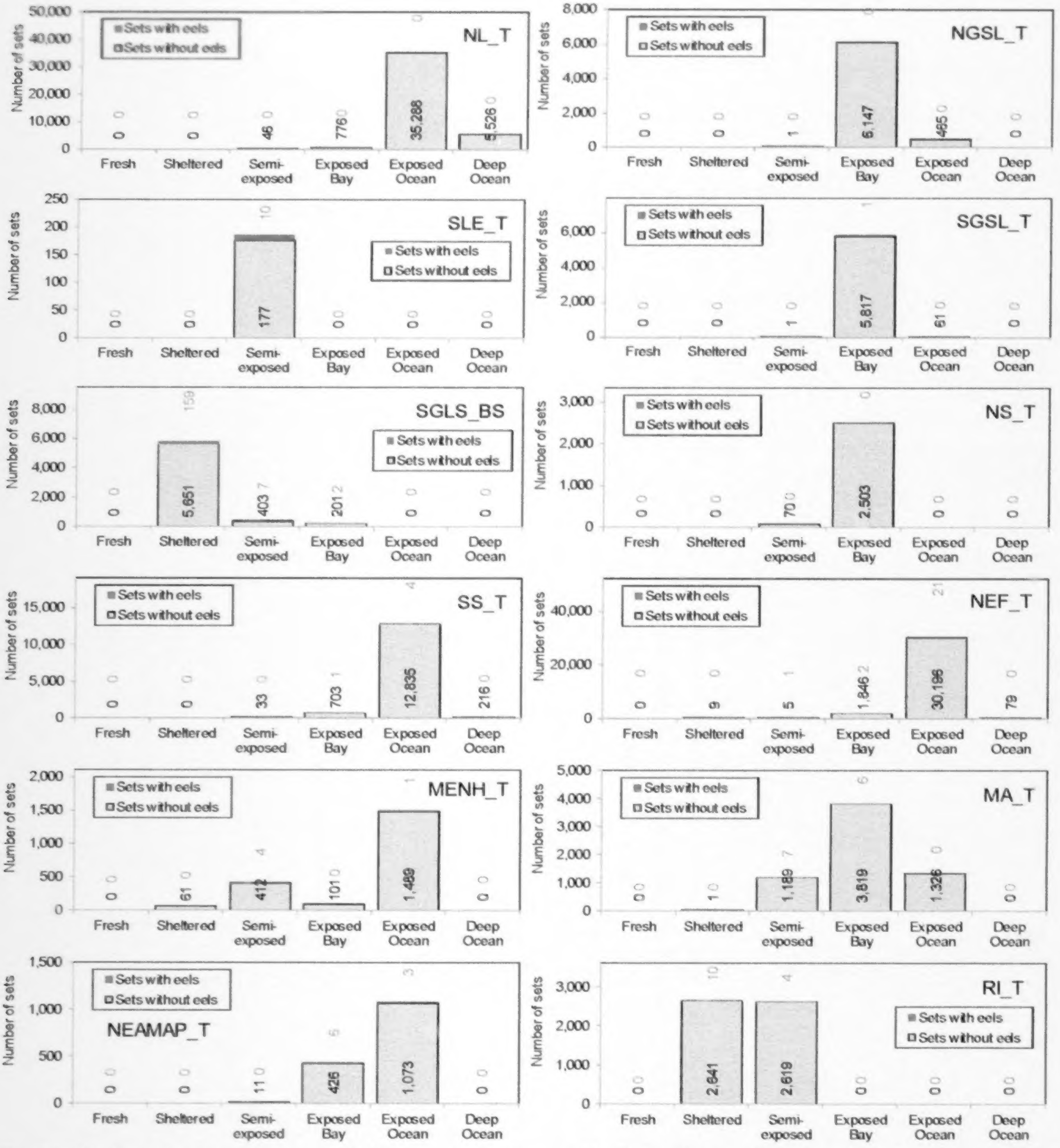


Fig. 44. Number of research survey sets by exposure category. Numbers of sets with eels are shown in red font and numbers of sets without eels are shown in black font. Major Chesapeake tributaries are the Potomac, Rappahannock, York, and James Rivers.

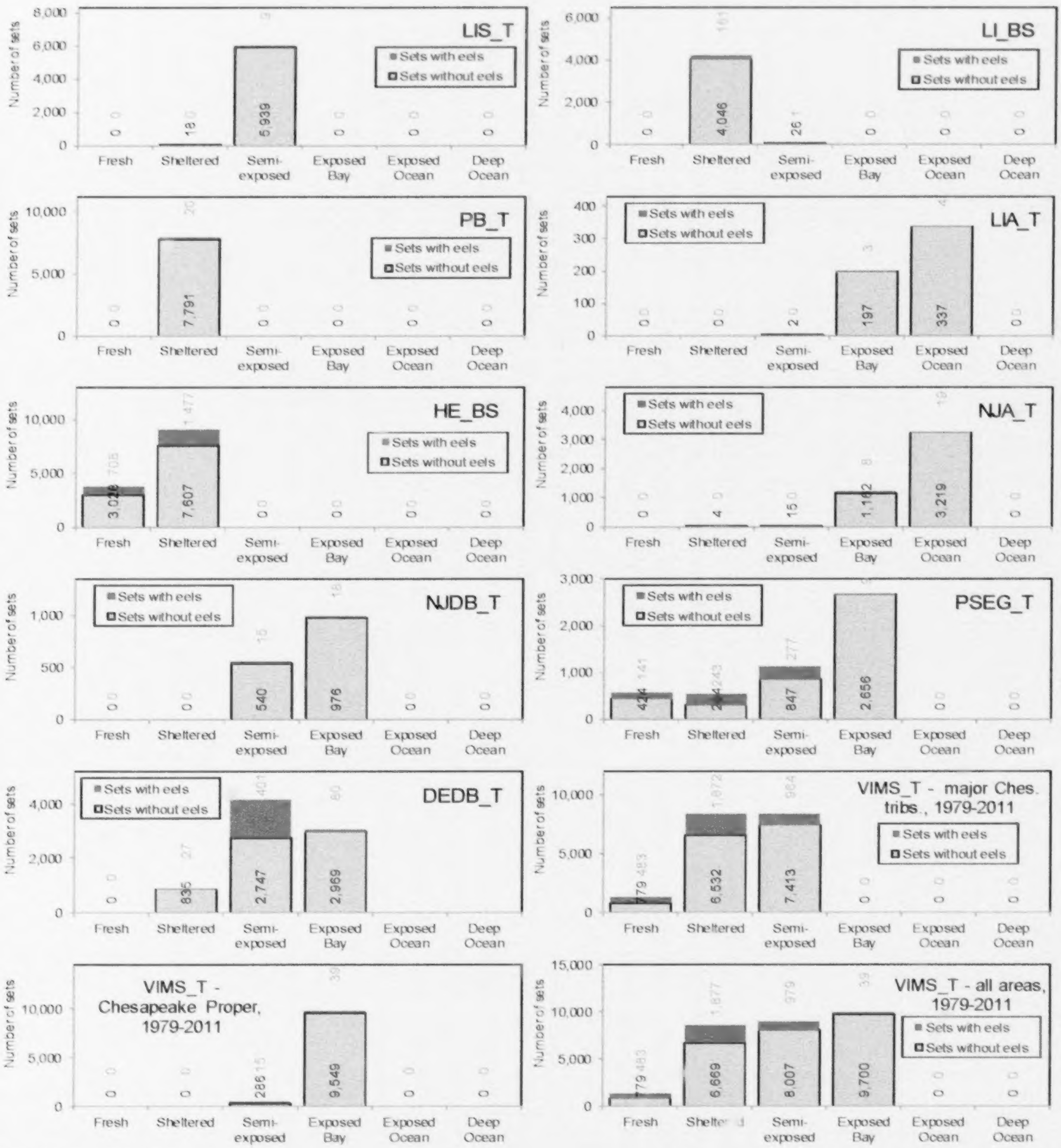


Fig. 44 (continued)

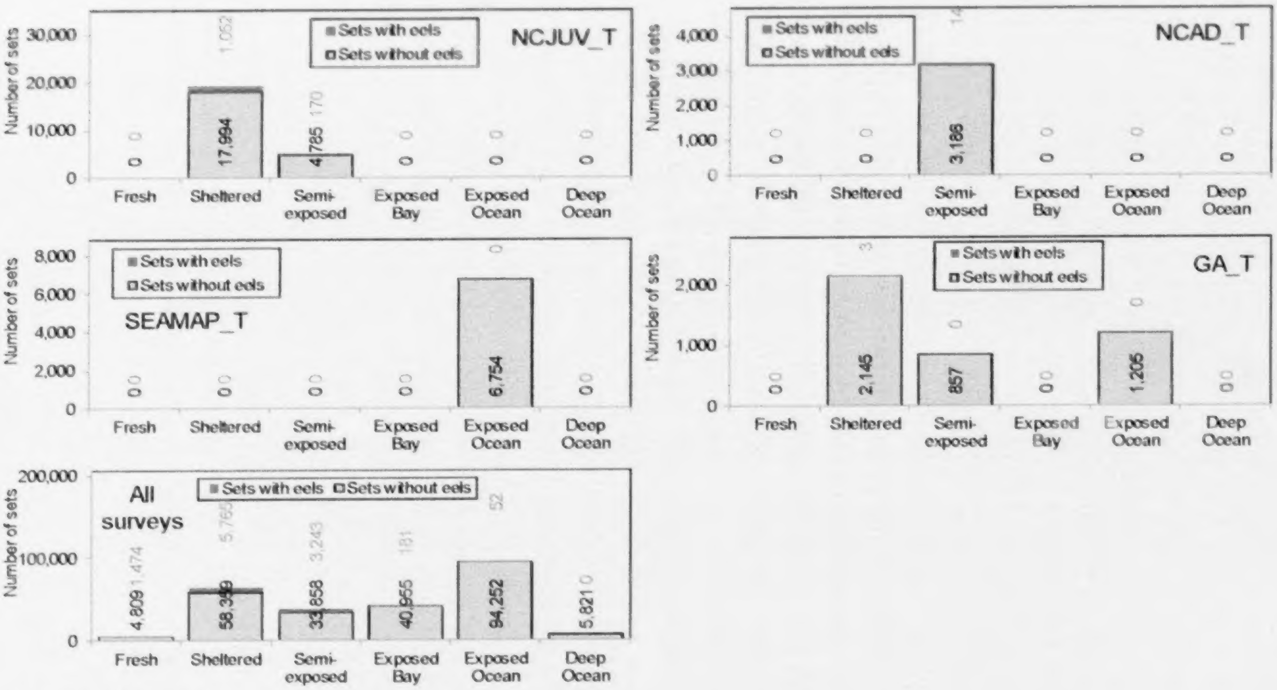


Fig. 44 (continued)

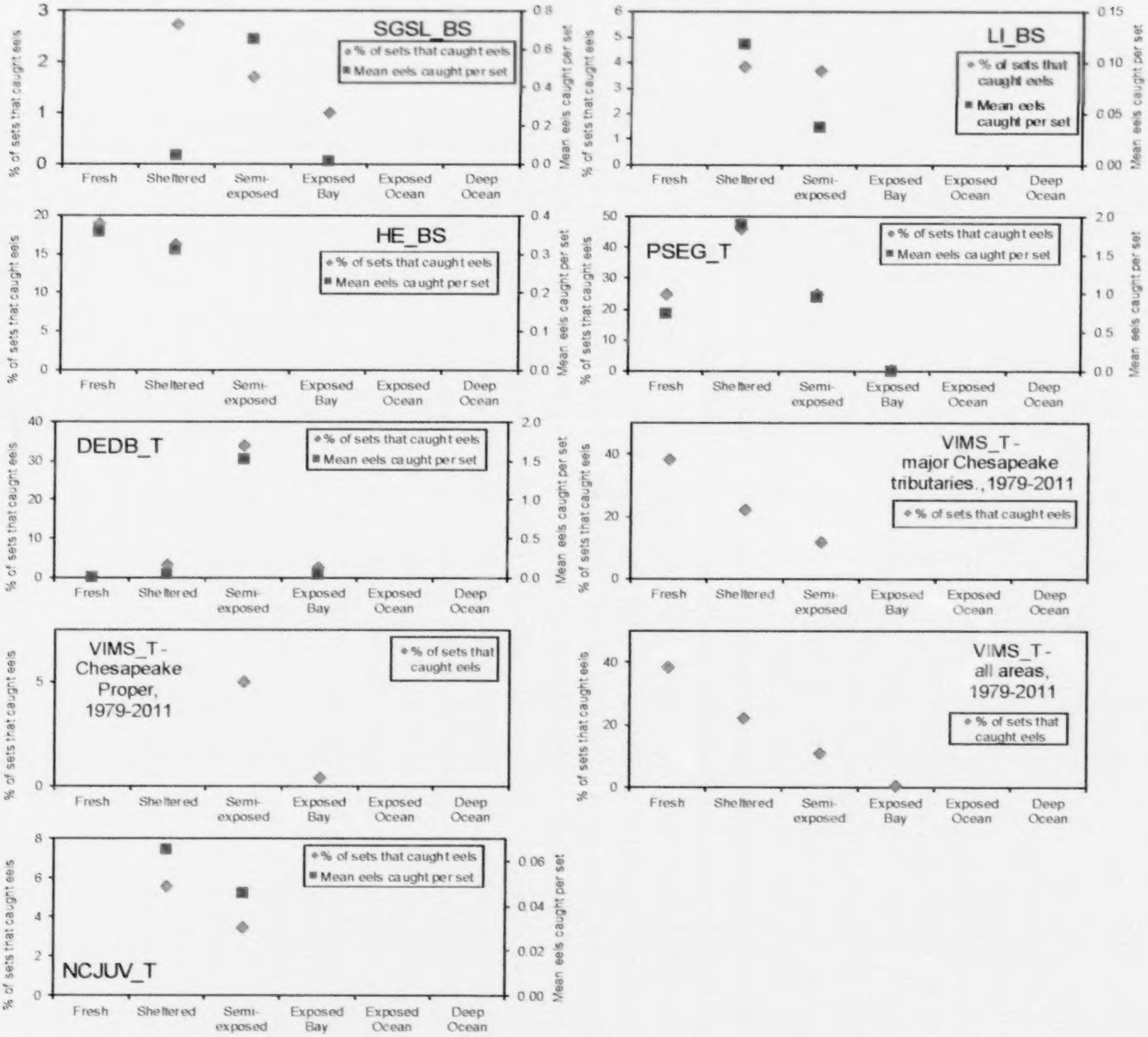


Fig. 45. Percent of sets that caught eels and mean eels caught per set by exposure zone in SGSL_BS, LI_BS, HE_BS, PSEG_T, DEDB_T, in major Chesapeake tributaries (Potomac, Rappahannock, York, James), in Chesapeake Bay Proper, in the full VIMS_T dataset, and NCJUV_T.

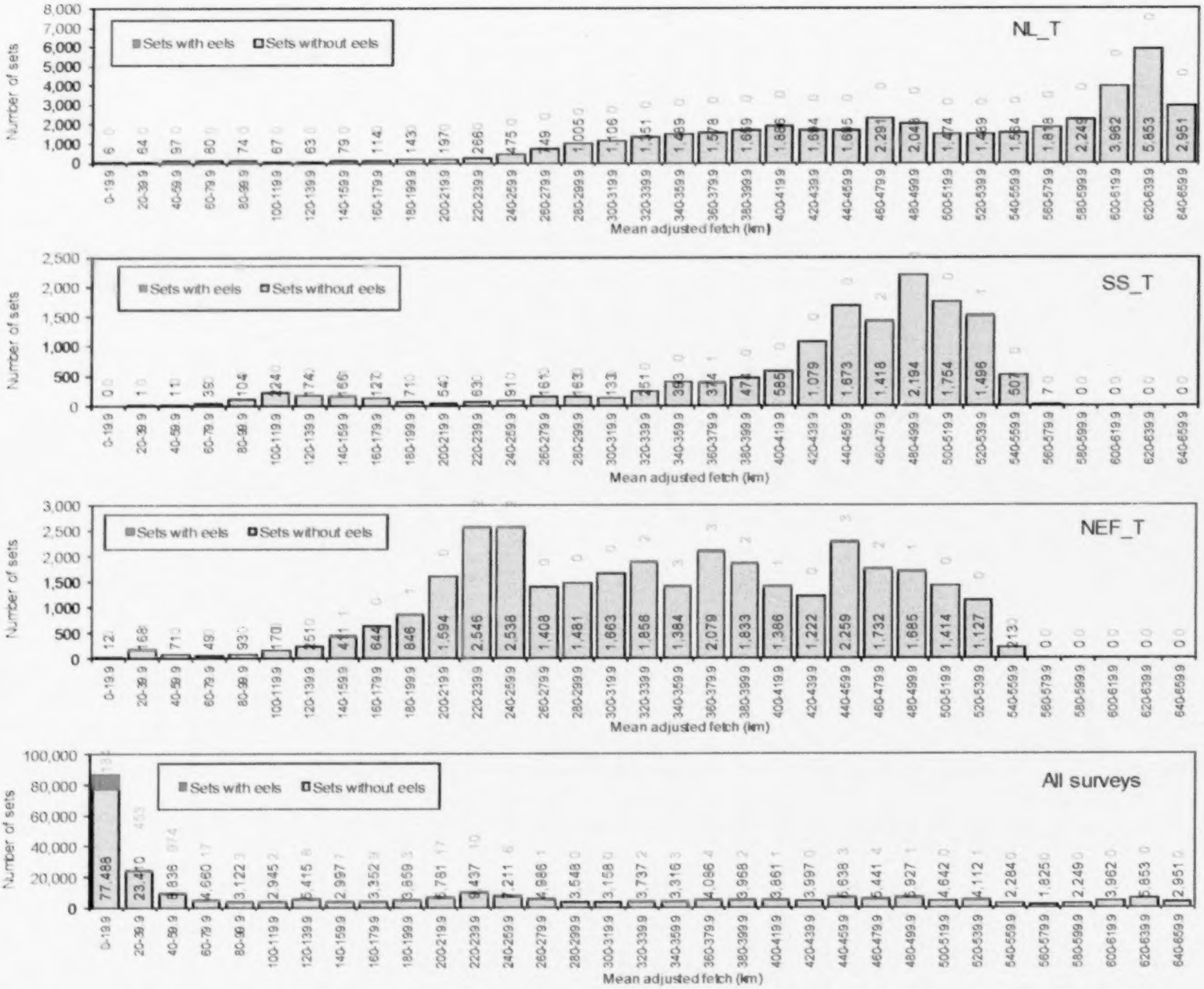


Fig. 46. Number of survey sets by mean fetch, adjusted for the frequency distribution of wind directions, by 20 km bins, for NL_T, SS_T, NEF_T, and all surveys. Numbers of sets with eels are shown in red font and numbers of sets without eels are shown in black font.

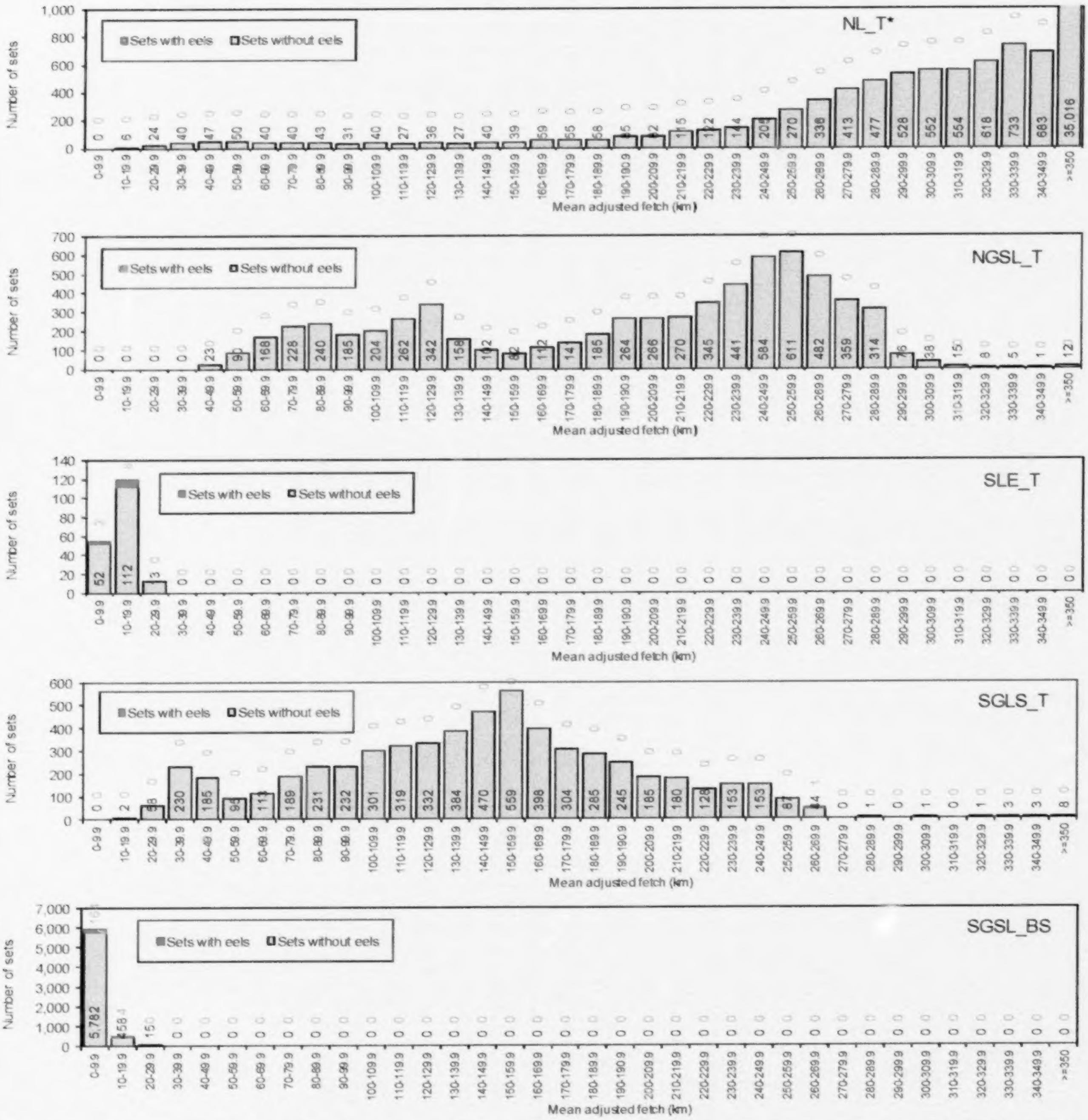


Fig. 47. Number of survey sets by mean fetch, adjusted for the frequency distribution of wind directions, by 10 km bins, up to a mean adjusted fetch of 350 km. An asterisk next to the survey name indicates that the number of sets at sites with fetch >350 km exceeds the vertical axis of the graph. Numbers of sets with eels are shown in red font and numbers of sets without eels are shown in black font.

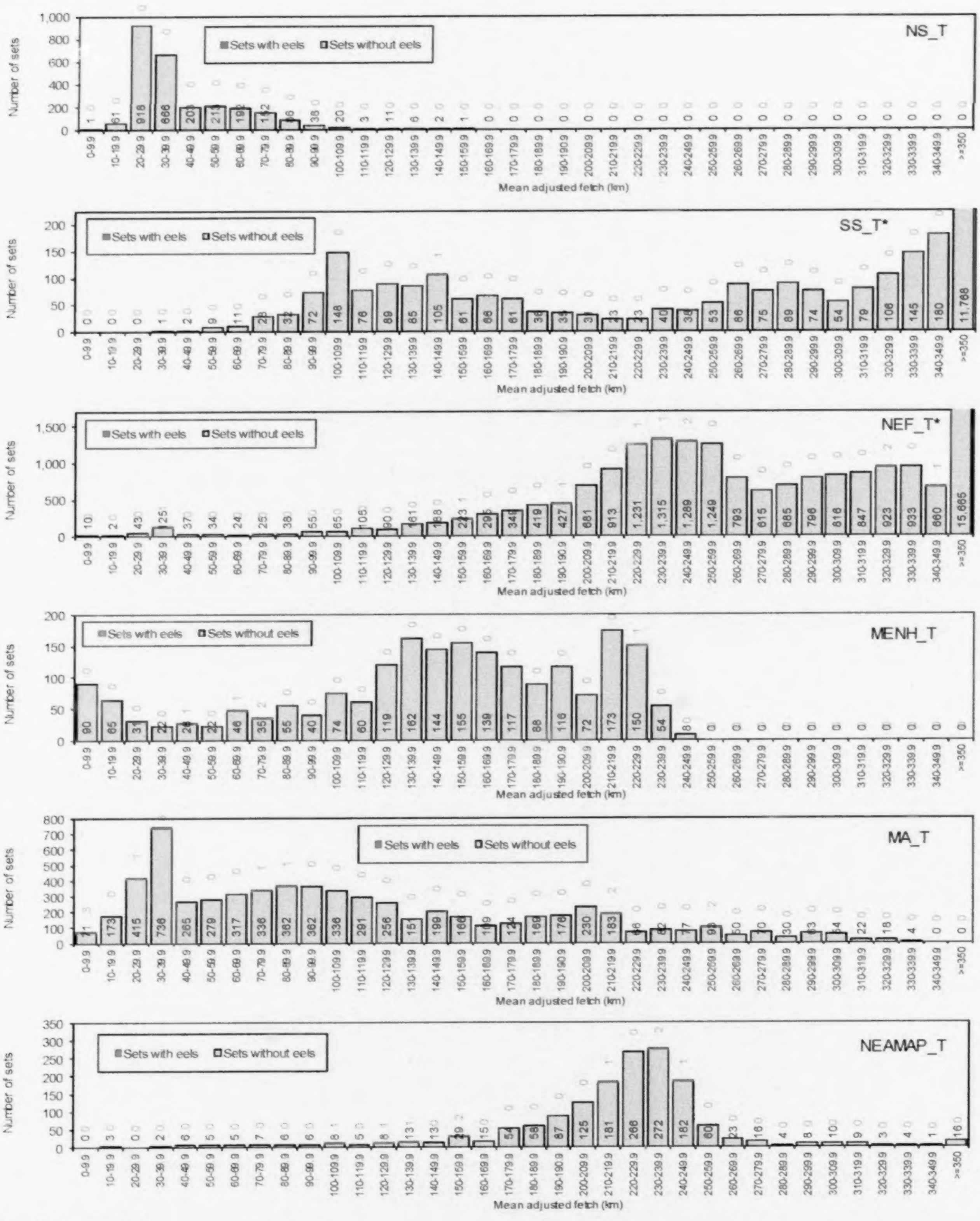


Fig. 47 (continued)

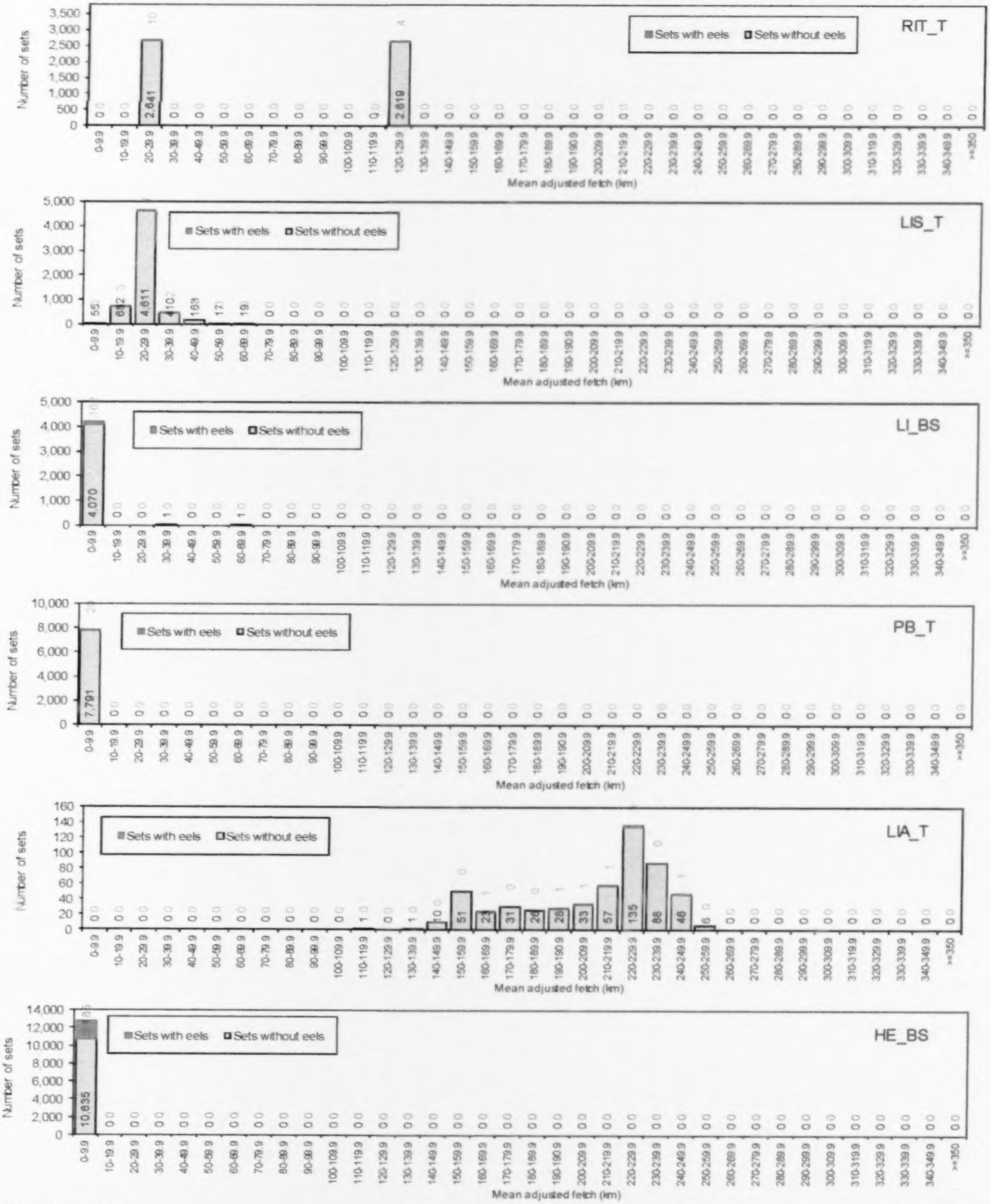
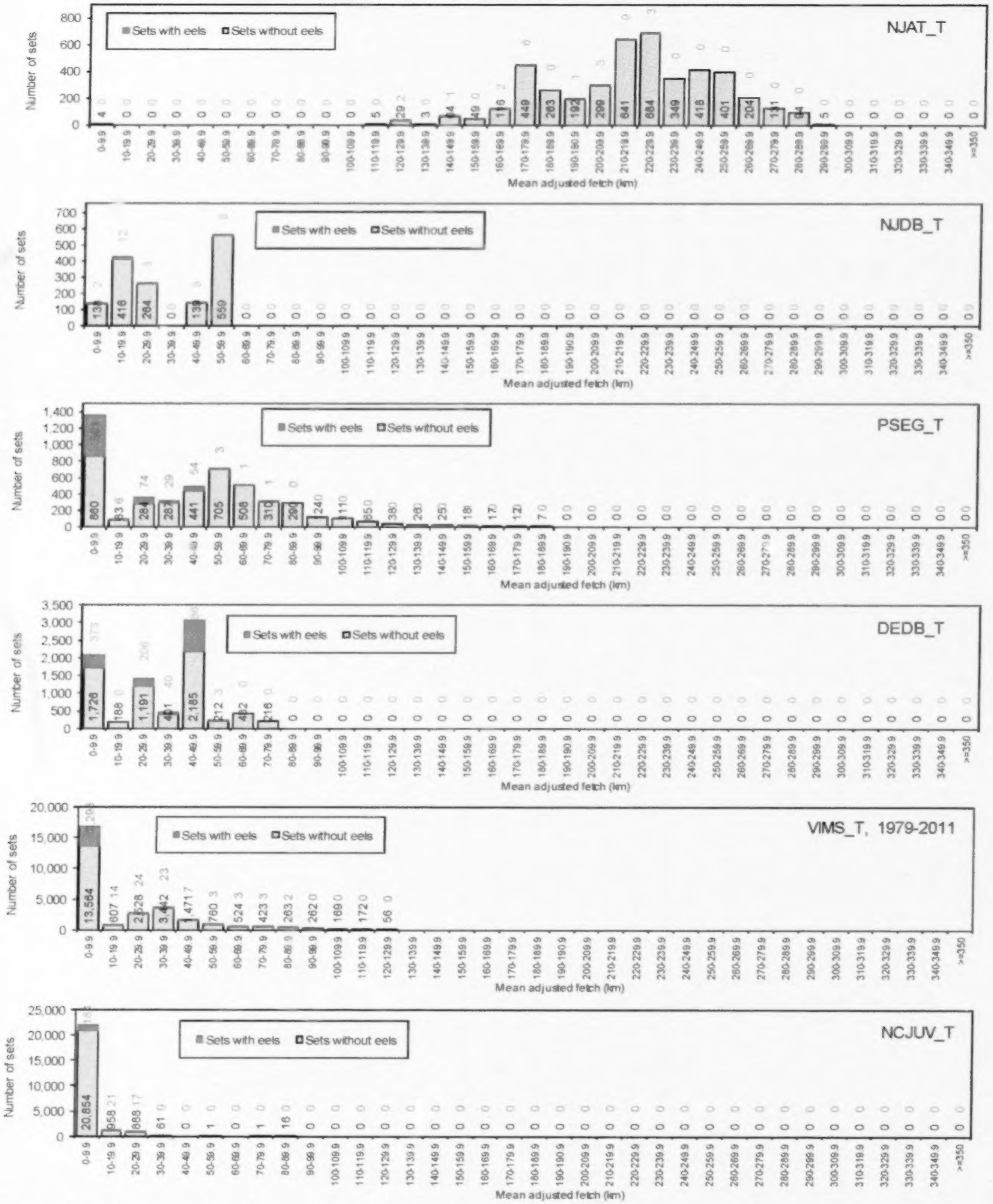


Fig. 47 (continued)



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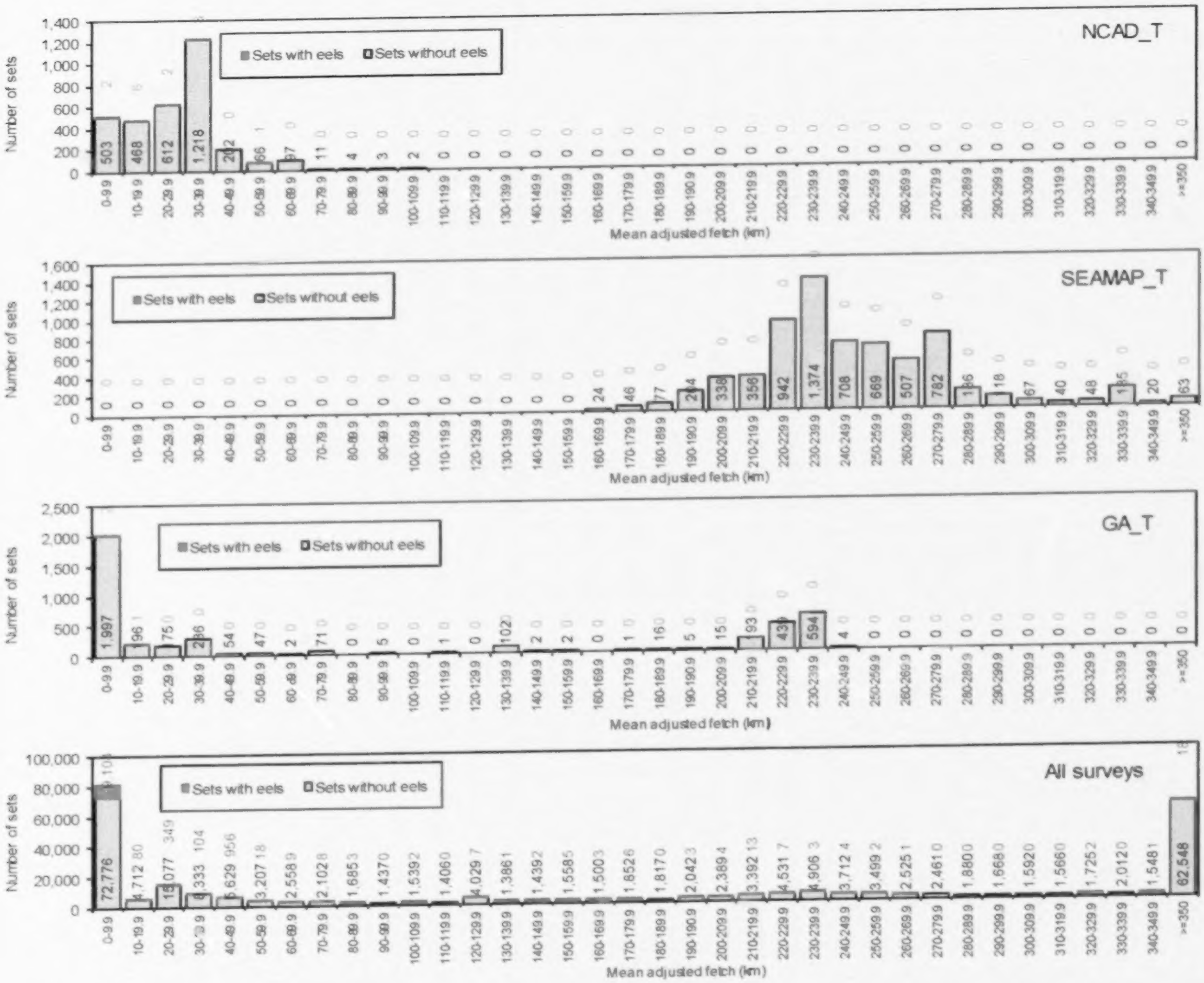


Fig. 47 (continued)

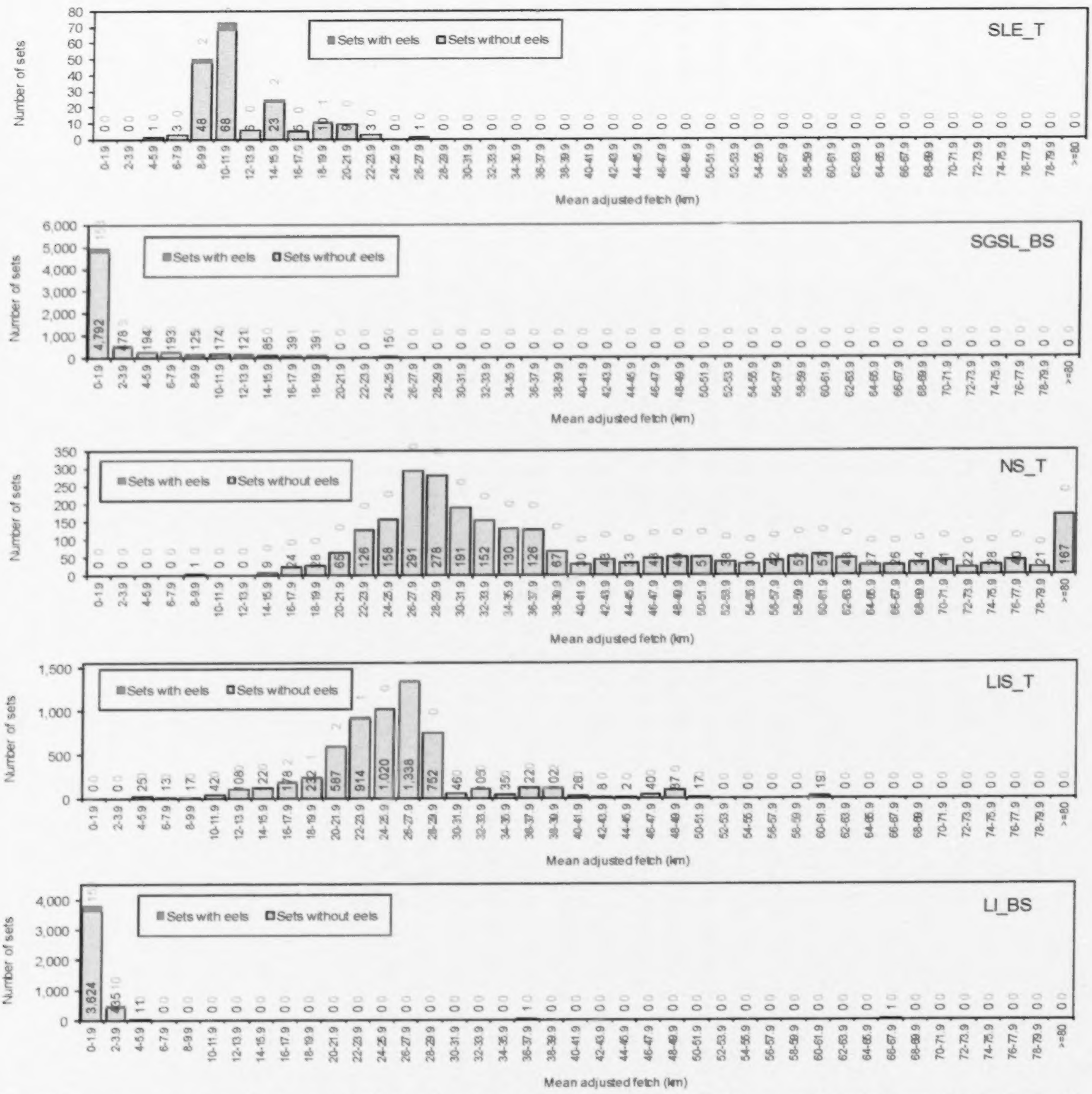


Fig. 48. Number of survey sets by mean fetch, adjusted for the frequency distribution of wind directions, by 2 km bins, for SLE_T, SGSL_BS, NS_T, LIS_T, LI_BS, PB_T, HE_BS, NJDB_T, PSEG_T, DEDB_T, VIMS_T, NCJUV_T, NCAD_T, and all surveys. Numbers of sets with eels are shown in red font and numbers of sets without eels are shown in black font.

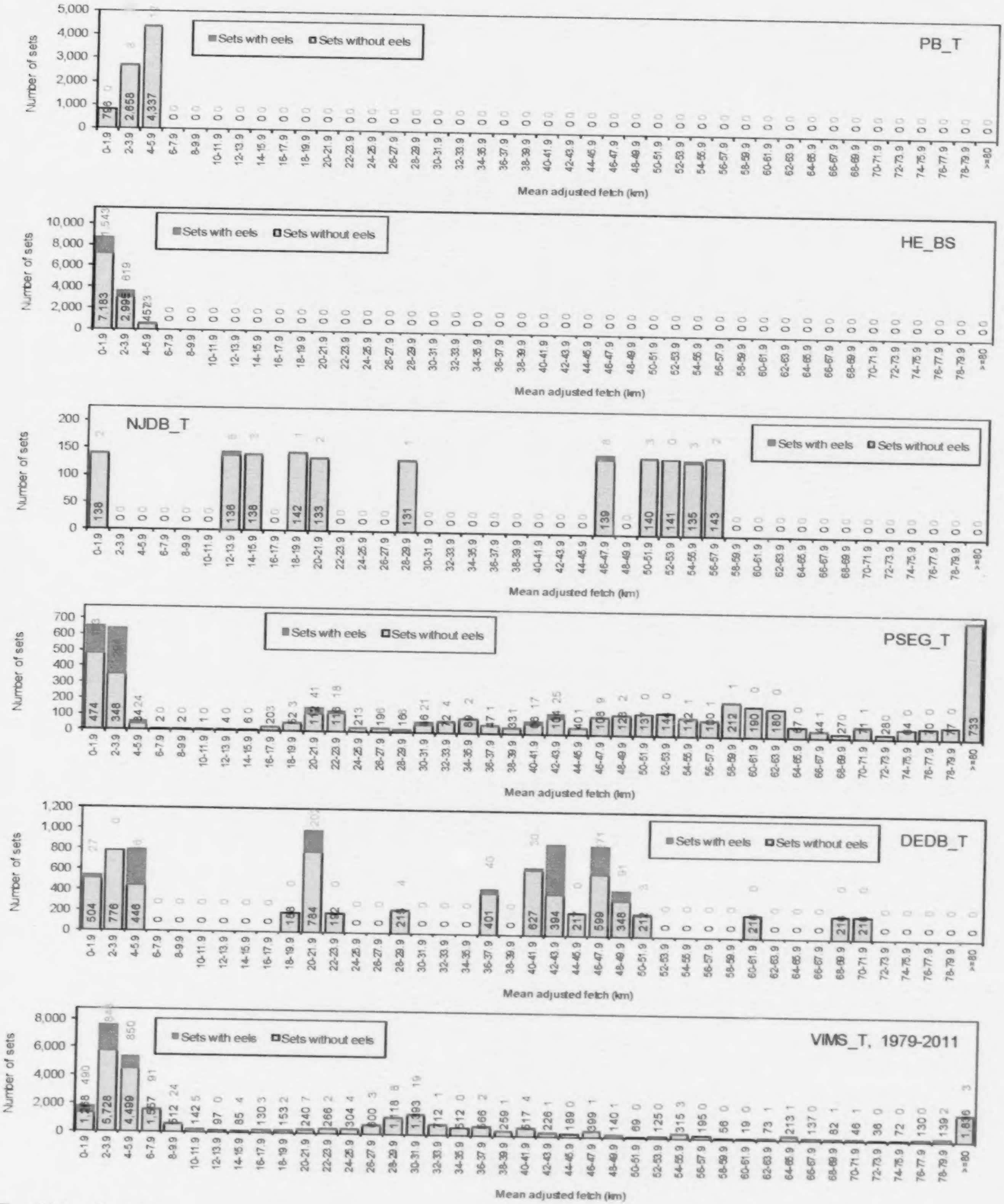


Fig. 48 (continued)

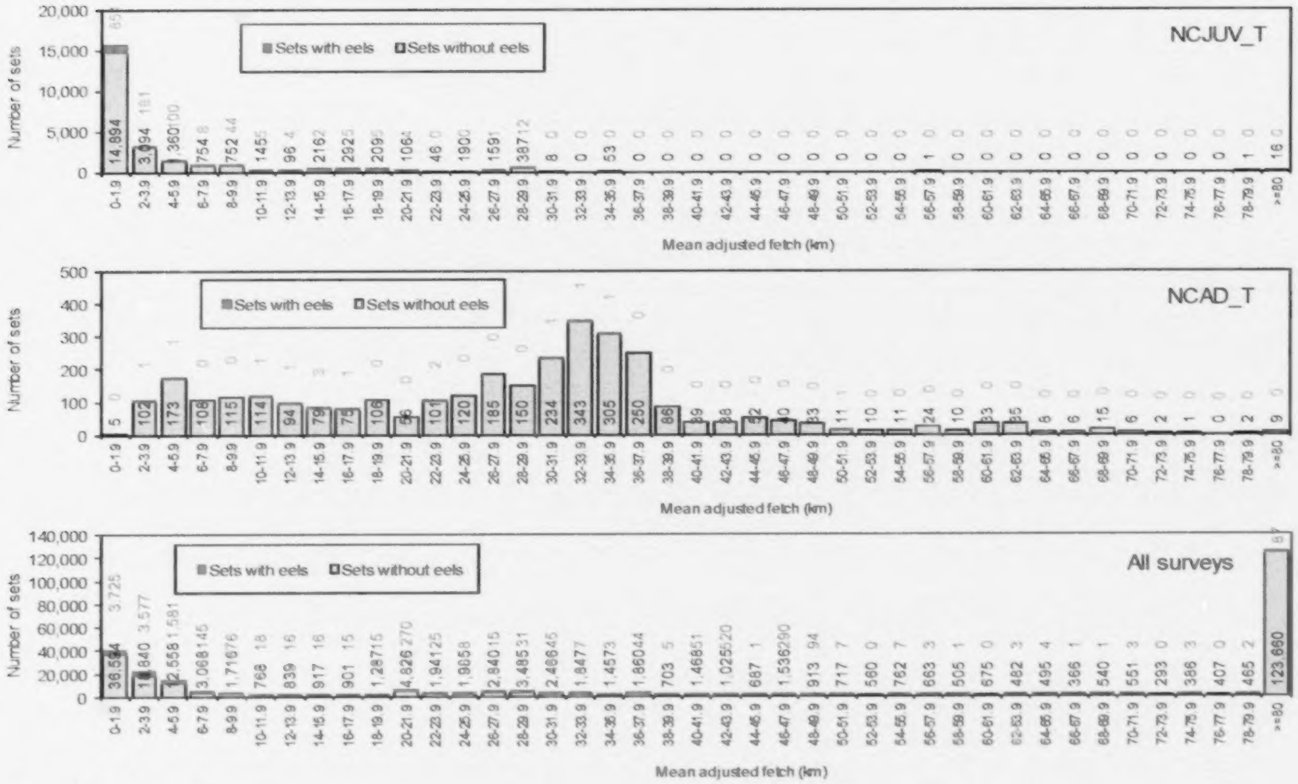


Fig. 48 (continued)

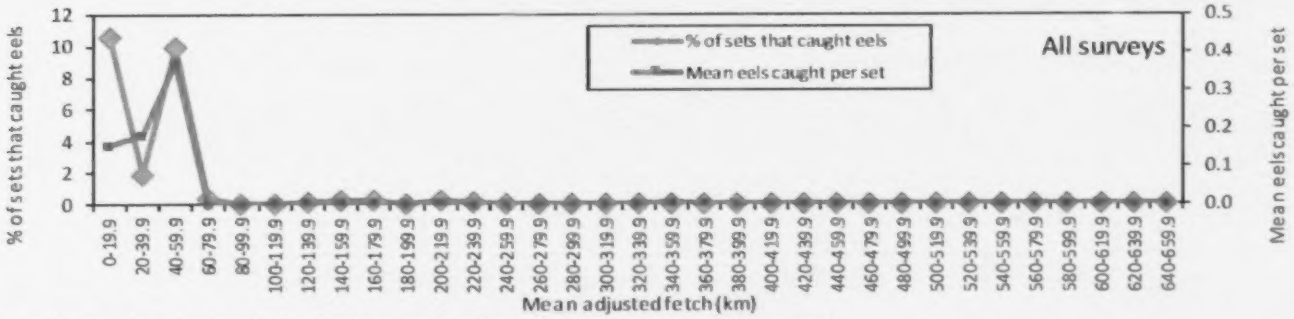


Fig. 49. Catch rate of eels by 20 km mean adjusted fetch bins, for all surveys.

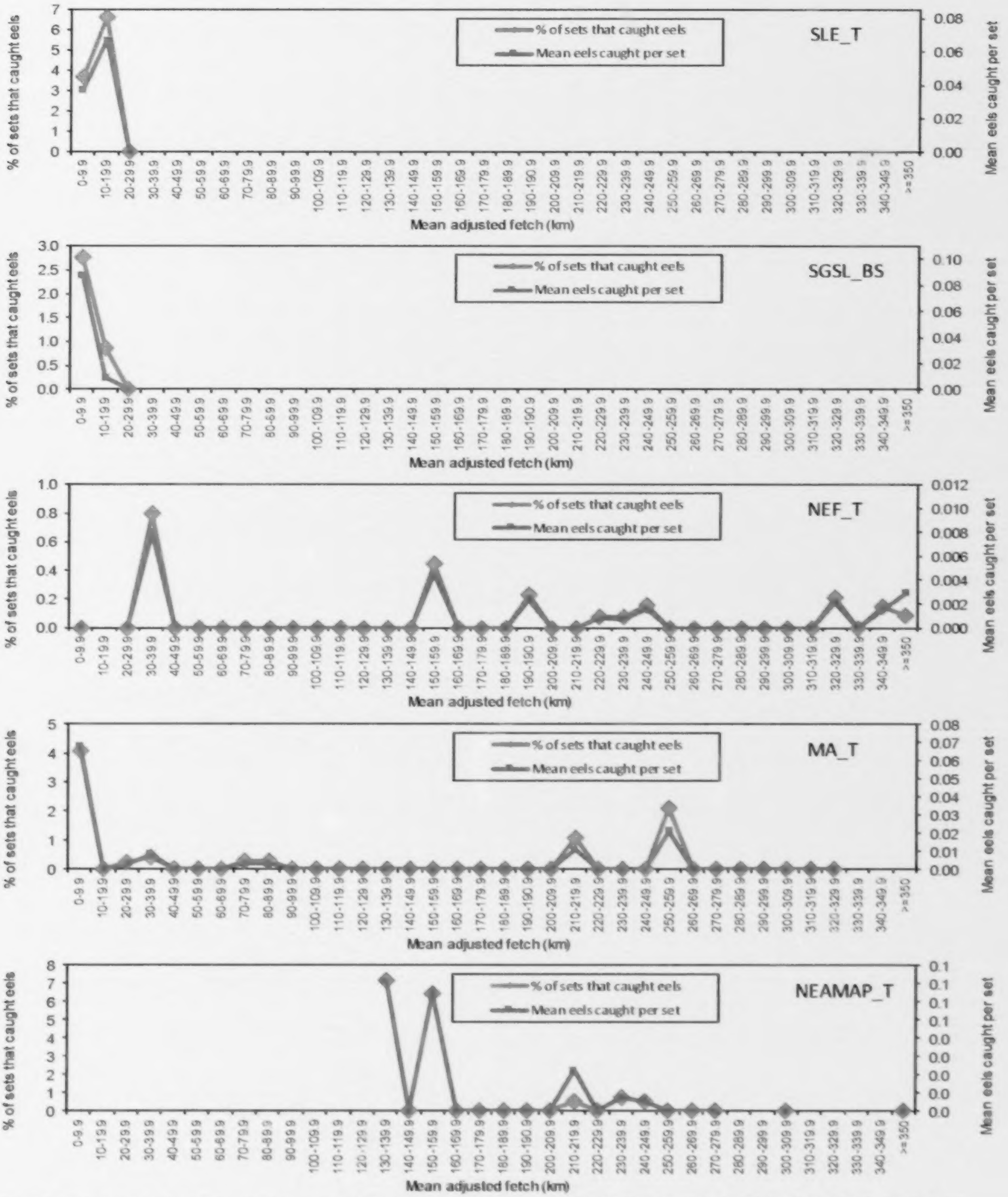


Fig. 50. Catch rate of eels by 10 km mean adjusted fetch bins, for SLE_T, SGSL_BS, NEF_T, MA_T, NEAMAP_T, RIT_T, LIS_T, LI_BS, PB_T, HE_BS, NJA_T, NJDB_T, PSEG_T, DEDB_T, VIMS_T, NCJUV_T, NCAD_T, and all surveys.

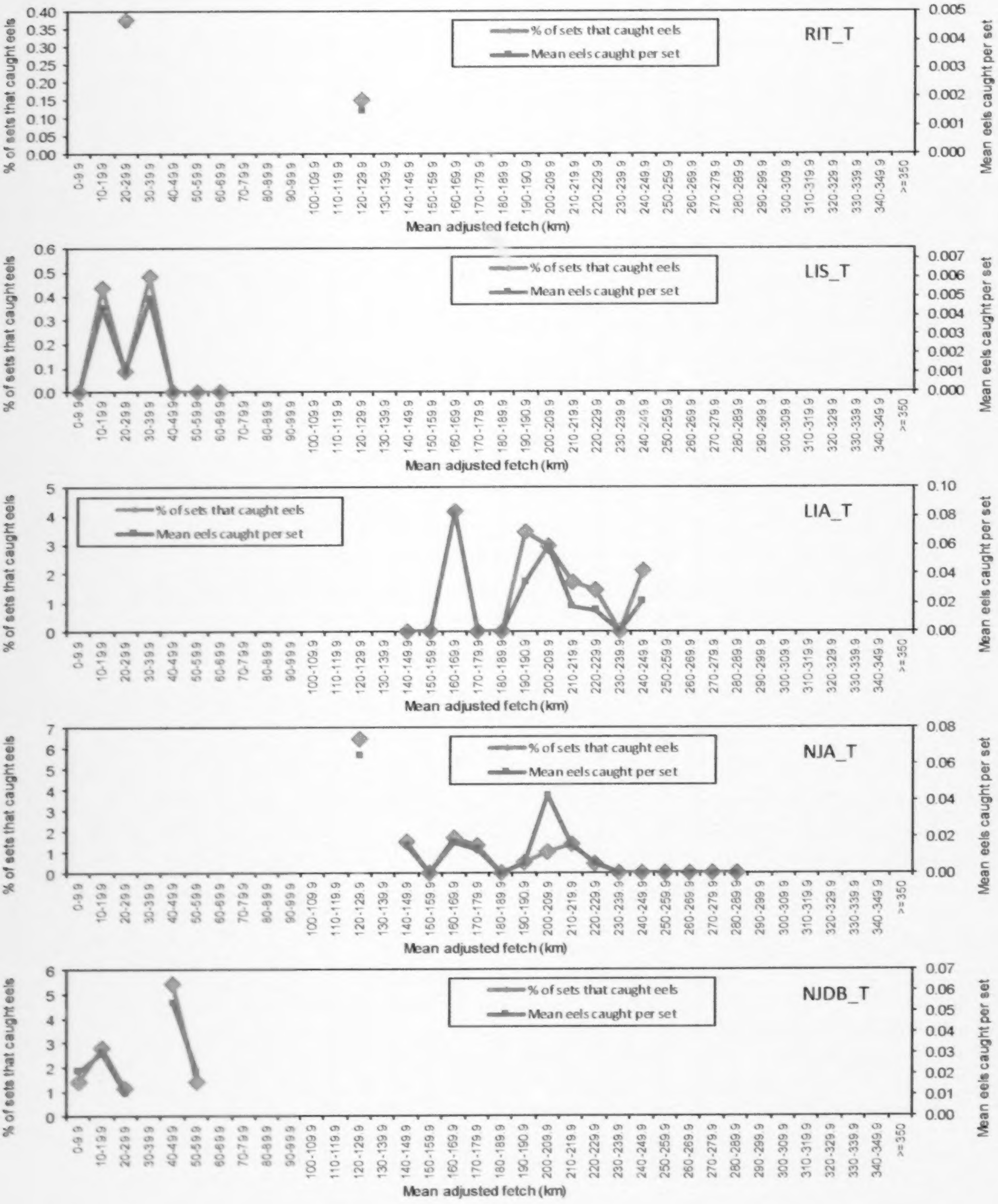


Fig. 50 (continued)

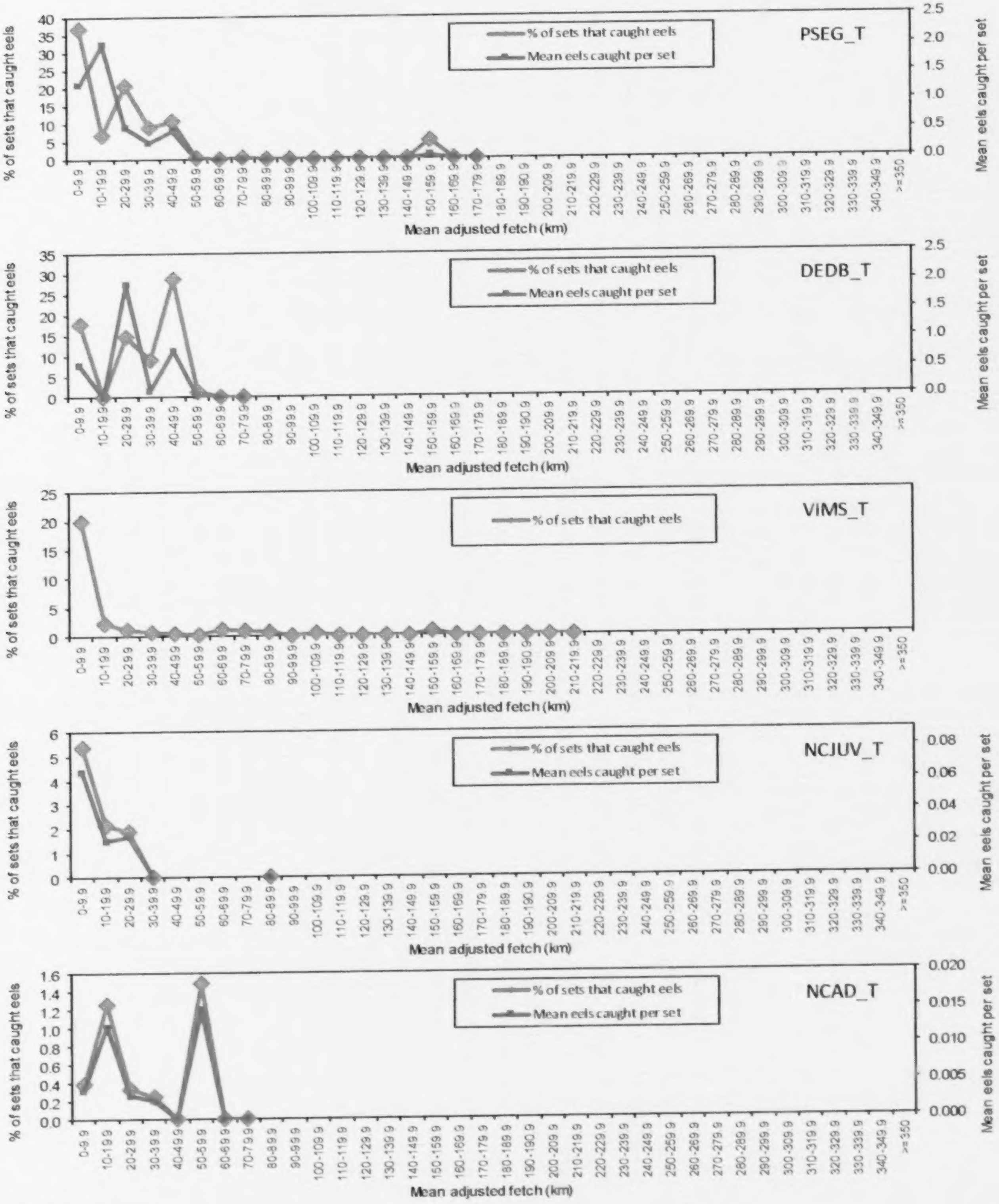


Fig. 50 (continued)

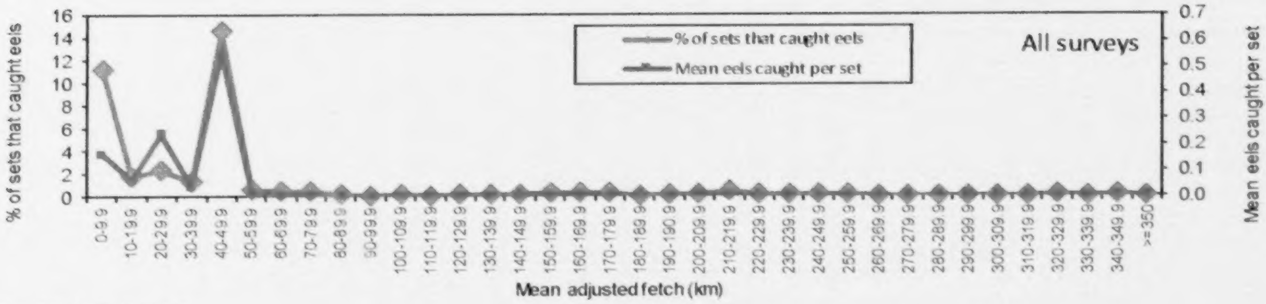


Fig. 50 (continued)

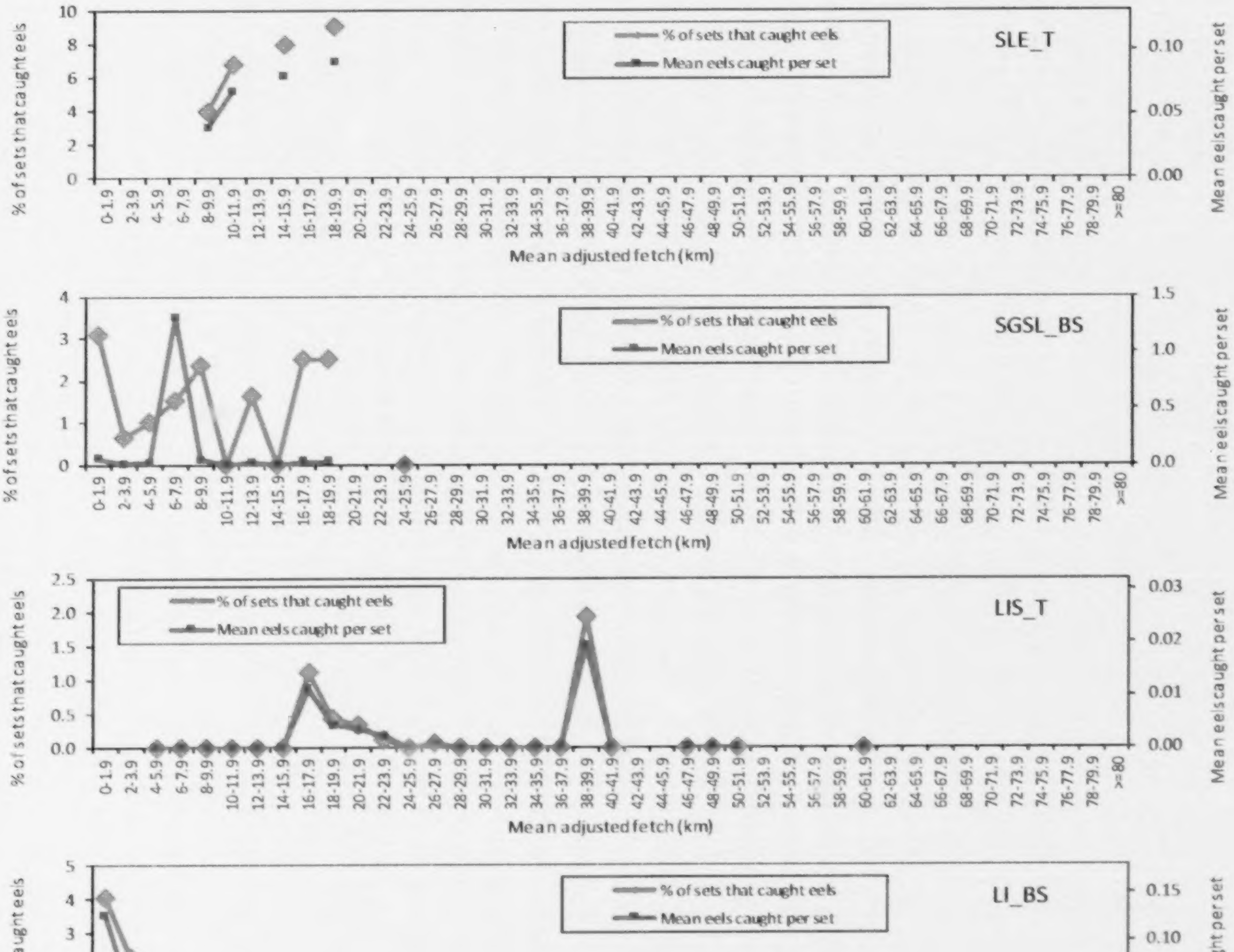
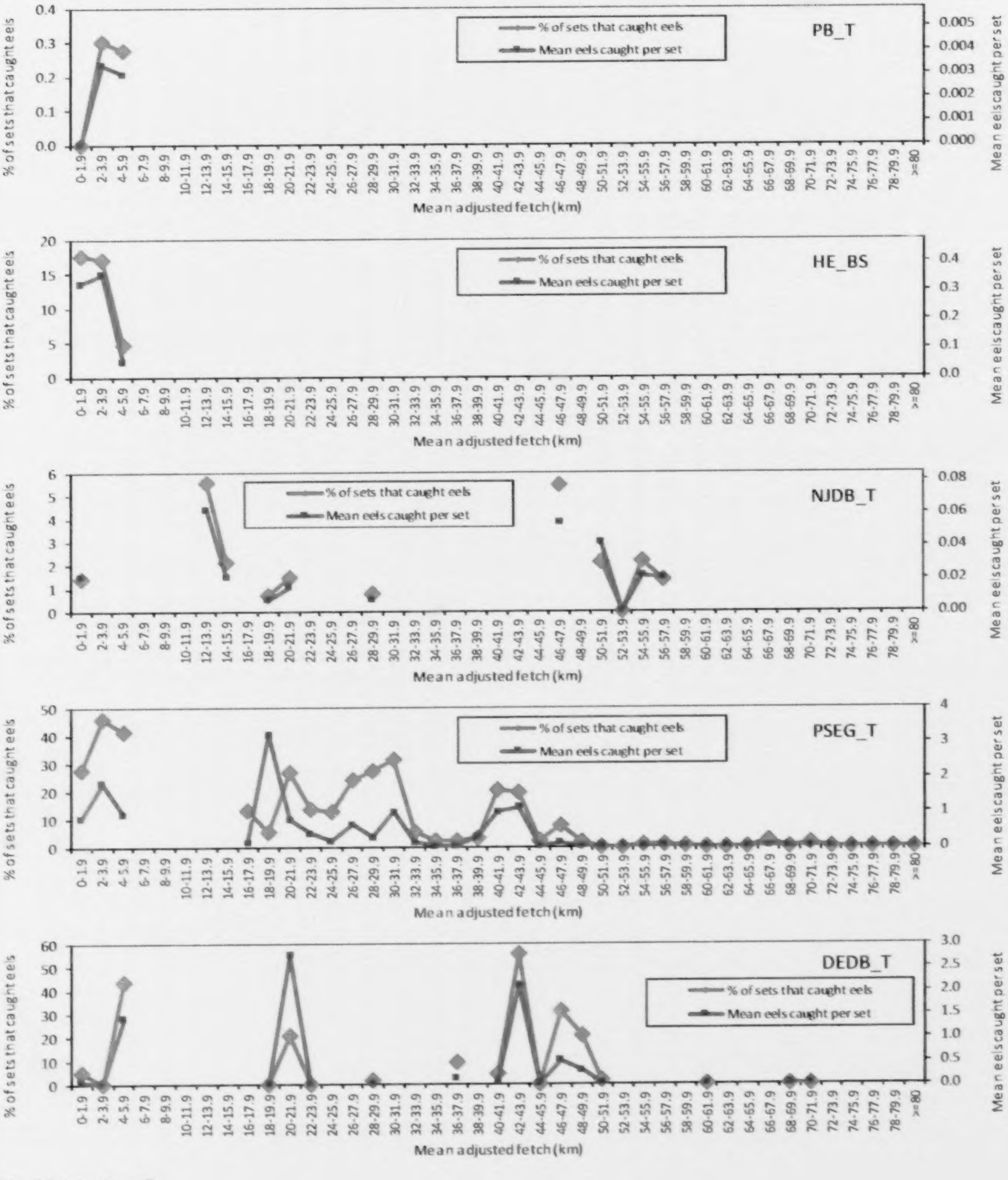


Fig. 51. Catch rate of eels by 2 km mean adjusted fetch bins, for SLE_T, SGSL_BS, LIS_T, LI_BS, PB_T, HE_BS, NJDB_T, PSEG_T, DEDB_T, VIMS_T, NCJUV_T, NCAD_T, and all surveys.



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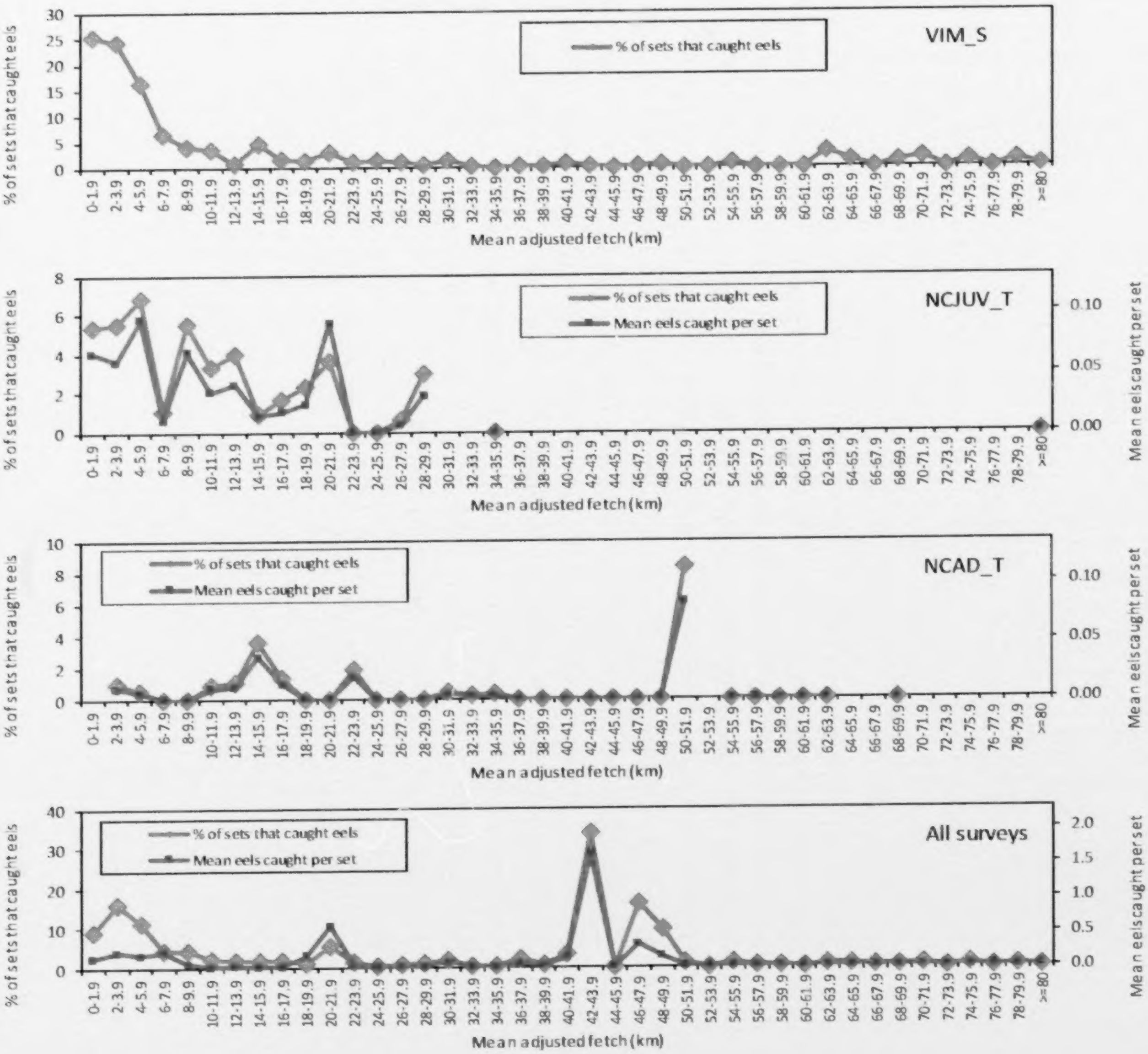

Fig. 51 (continued)

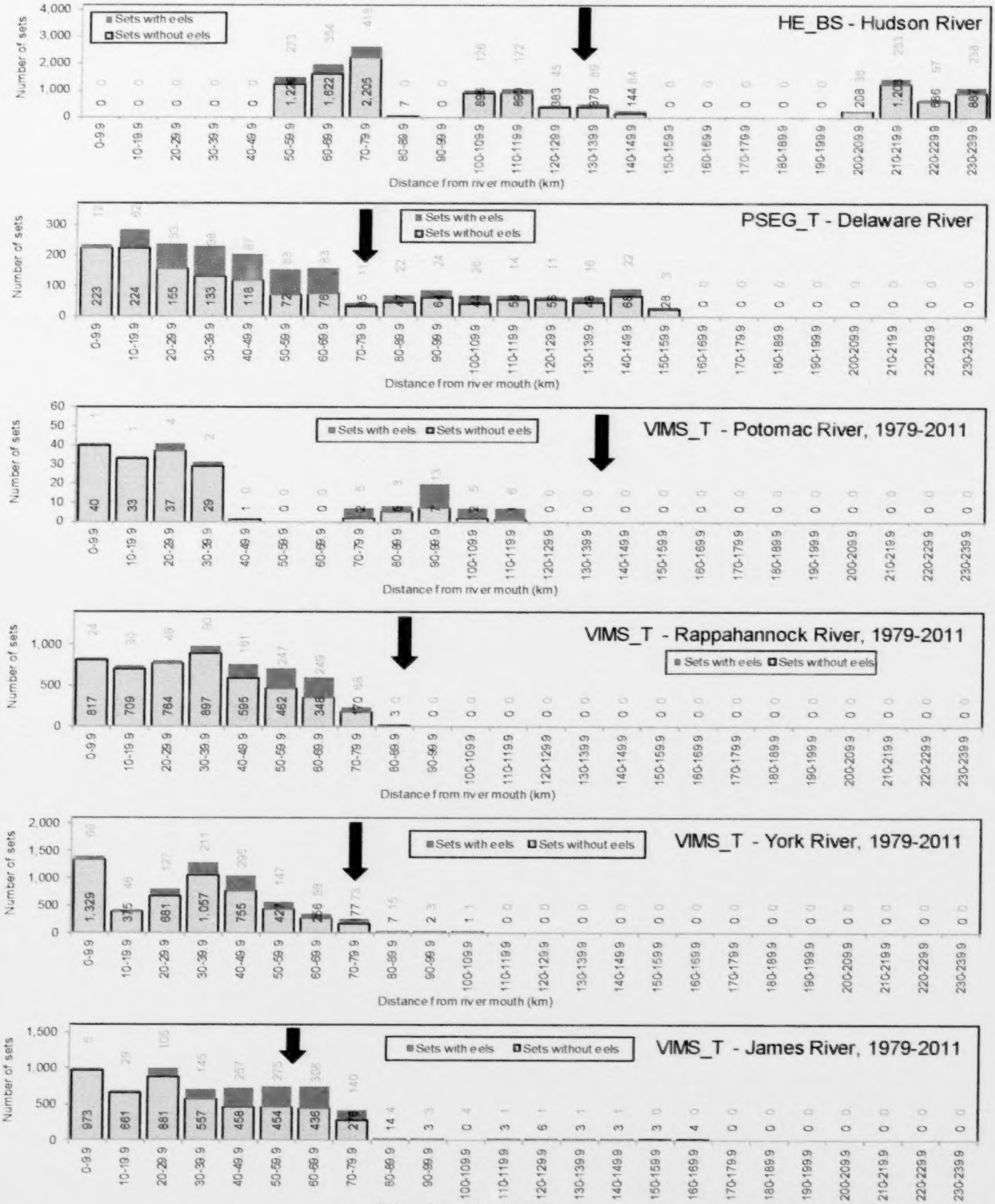

Fig. 52. Number of research survey sets by river km, in the Hudson, Delaware, Potomac, Rappahannock, York, and James Rivers. Numbers of sets with eels are shown in red font and numbers of sets without eels are shown in black font. Black arrows indicate the boundary between the saline and the fresh estuary.

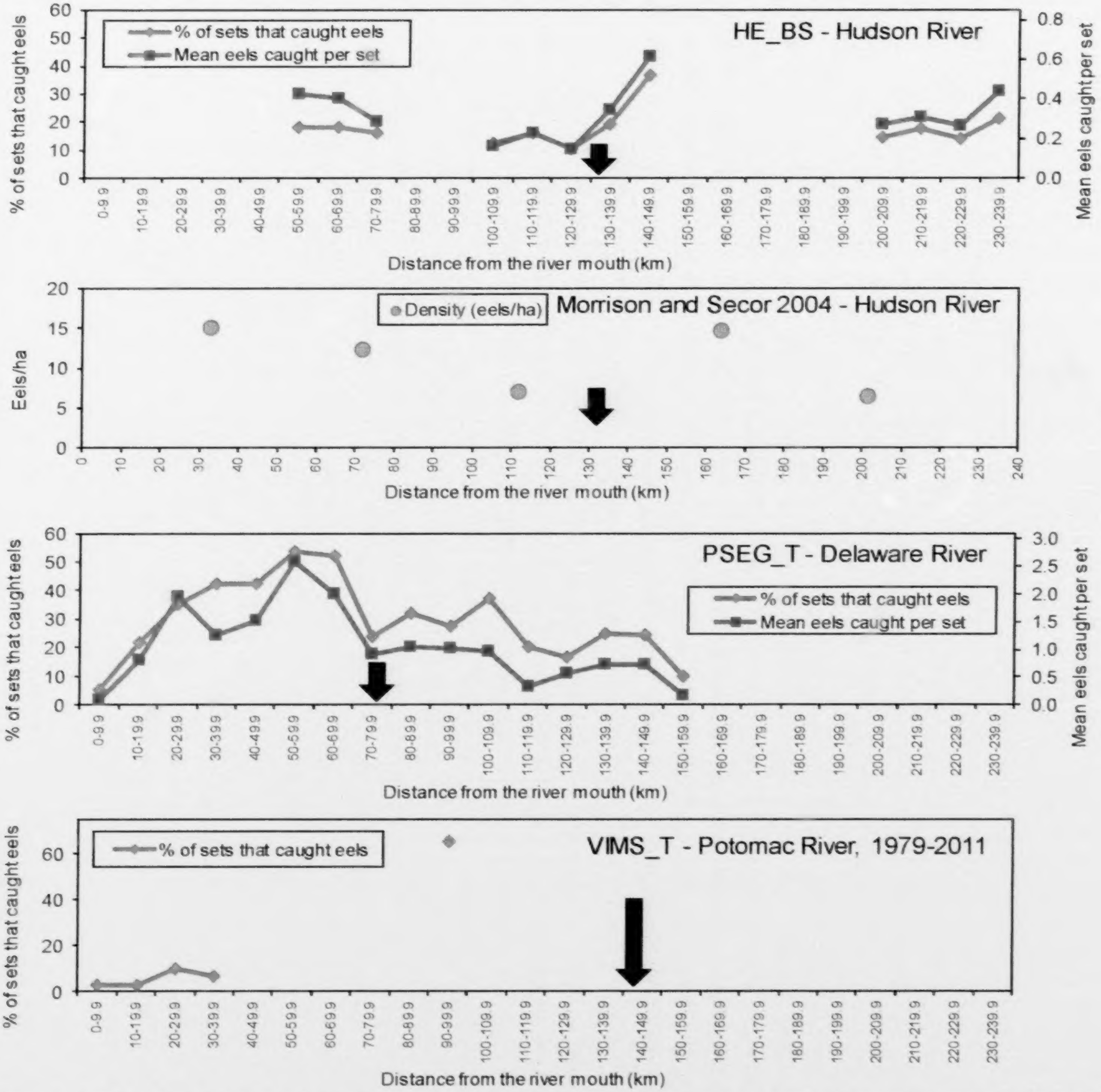

Fig. 53. Catch rate of eels in the Hudson, Delaware, Potomac, Rappahannock, York, and James Rivers, in relation to river km. Eel density in the Hudson River, estimated by capture-mark-recapture (Morrison and Secor 2004), is also shown. Black arrows indicate the boundary between the saline and the fresh estuary.

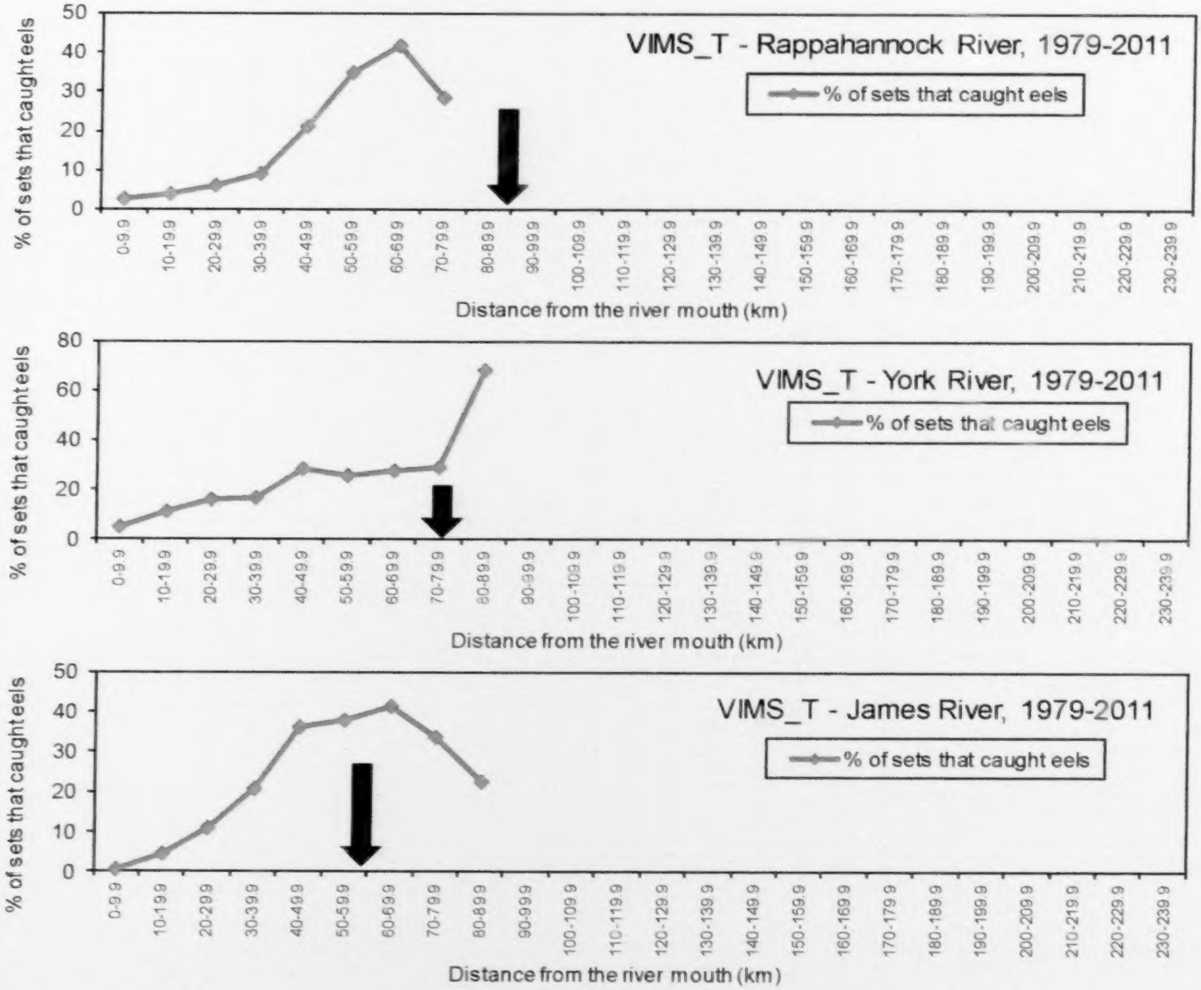

Fig. 53 (continued)

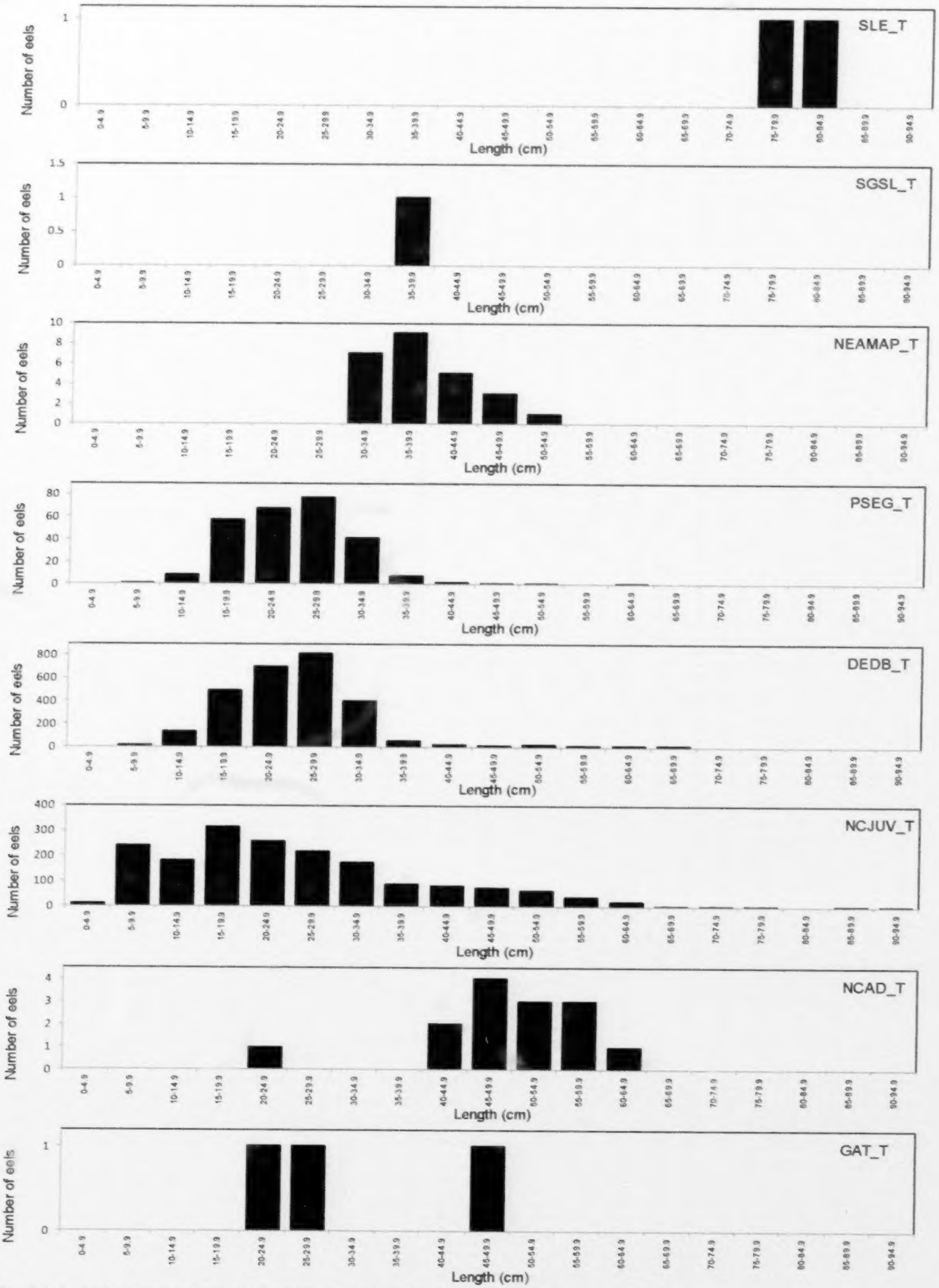

Fig. 54. Length frequency distribution of eels measured on surveys.

Appendix A. Surveys in tidal waters of the east and Gulf of Mexico coasts of North America that are likely capable of catching American eels, but which were not analyzed in the present paper.

| | | |
|---|---|---|
| NB/NS/PE | Bay of Chaleur and Northumberland Strait scallop dredge survey | L. Davidson and M. Niles, DFO unpubl. |
| NS | Beach seine survey of the Atlantic and Fundy coasts of mainland NS | O'Connor 2008 |
| ME | Kennebec and Penobscot Rivers juvenile striped bass and alosine beach seine survey | US Fish & Wildlife Service 2013 |
| NH | New Hampshire estuarine juvenile finfish beach seine survey | US Fish & Wildlife Service 2013 |
| MA | Massachusetts winter flounder beach seine survey | US Fish & Wildlife Service 2013 |
| RI | Rhode Island (Narragansett Bay, Rhode Island Sound, Block Island Sound) seasonal fishery assessment trawl survey | US Fish & Wildlife Service 2013 |
| RI | Rhode Island coastal pond and embayment beach seine survey | US Fish & Wildlife Service 2013 |
| RI | Narragansett Bay and Sakonnet River beach seine survey | US Fish & Wildlife Service 2013 |
| CT | Connecticut winter flounder and small forage fish beach seine survey | US Fish & Wildlife Service 2013 |
| CT | Connecticut and Thames Rivers river herring beach seine survey | US Fish & Wildlife Service 2013 |
| NY | Long Island Sound trap survey | US Fish & Wildlife Service 2013 |
| NY | Hudson Estuary juvenile striped bass beach seine survey | US Fish & Wildlife Service 2013 |
| NY | Hudson Estuary juvenile stripe bass trawl survey | Rago et al. 1995 |
| NY, NJ | Lower Hudson and Raritan Estuary trawl survey | Reid et al. 1999 |
| NJ | Rutgers Great Bay trawl survey | ASMFC 2013 |
| NJ | PSEG Delaware Bay beach seine survey | PSEG 2009 |
| NJ, PA, DE | Delaware River juvenile striped bass beach seine survey | US Fish & Wildlife Service 2013 |
| DE | Delaware Bay 9.1 m trawl survey | US Fish & Wildlife Service 2013 |
| DE | Indian River and Rehoboth Bay trawl survey | US Fish & Wildlife Service 2013 |
| MD | Maryland Atlantic coastal bays trawl survey | Pincin et al. 2014 |
| MD | Maryland Atlantic coastal bays beach seine survey | US Fish & Wildlife Service 2013 |
| MD | Patuxtent and Choptank Rivers and Marshyhope Creek juvenile shad beach seine survey | US Fish & Wildlife Service 2013 |
| MD | Choptank River fyke net survey | US Fish & Wildlife Service 2013 |
| MD | Upper Chesapeake Bay winter trawl survey | US Fish & Wildlife Service 2013 |
| MD | Chester River juvenile alosine beach seine survey | US Fish & Wildlife Service 2013 |
| MD | Chester River juvenile alosine trawl survey | US Fish & Wildlife Service 2013 |
| MD | Maryland portion of Chesapeake Bay striped bass beach seine survey | US Fish & Wildlife Service 2013 |
| MD | Maryland Chesapeake Bay 4.9 m trawl survey | US Fish & Wildlife Service 2013 |
| VA | Virginia fresh-oligohaline tidal river boat electrofishing survey | US Fish & Wildlife Service 2013 |
| VA | Virginia fresh-oligohaline tidal river catfish boat electrofishing survey | US Fish & Wildlife Service 2013 |
| VA | Virginia Potomac tributaries northern snakehead boat electofishing survey | US Fish & Wildlife Service 2013 |
| VA | Virginia lower Chesapeake Bay juvenile striped bass beach seine survey | US Fish & Wildlife Service 2013 |
| VA | Chesapeake Bay multispecies monitoring and assessment trawl survey | US Fish & Wildlife Service 2013 |
| DC | District of Columbia beach seining survey | US Fish & Wildlife Service 2013 |
| DC | District of Columbia nighttime push net survey | US Fish & Wildlife Service 2013 |
| DC | District of Columbia eel pot survey | US Fish & Wildlife Service 2013 |
| NC | Albermarle Sound juvenile striped bass trawl survey | Rago et al. 1995 |
| NC | North Carolina alosine seine survey | ASMFC 2013 |
| SC | South Carolina estuarine boat electrofishing survey | ASMFC 2013 |
| SC | SouthCarolina longline survey | ASMFC 2013 |
| GA | Georgia juvenile finfish trawl survey | Georgia Dept. Natural Resources 2008 |
| GA | Georgia St. Simons and St. Andrew beach seine survey | Georgia Dept. Natural Resources 2008 |
| FL to TX | SEAMAP summer and fall Gulf of Mexico shrimp/groundfish trawl survey | Rester et al. 2014, Monk et al. 2015 |
| AL | Alabama Fisheries Assessment and Monitoring Program trawl survey | Valentine et al. 2006 |
| AL | Alabama Fisheries Assessment and Monitoring Program seine survey | Valentine et al. 2006 |